

Missouri Department of Transportation
Bridge Division

Bridge Design Manual
Section 3.42

Revised 08/19/2002

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DESIGN ASSUMPTIONS & PROCEDURES

Design

Design Unit Stresses (also see note A1.1 in Section 4)

Reinforcement Concrete

Reinforcing Steel (Grade 60) $f_s = 24,000 \text{ psi}$, $f_y = 60,000 \text{ psi}$

Class B2 Concrete (Superstructure) $f_c = 1,600 \text{ psi}$, $f'_c = 4,000 \text{ psi}$

Structural Steel:

Structural Carbon Steel (ASTM A709 Grade 36)

$f_s = 20,000 \text{ psi}$, $f_y = 36,000 \text{ psi}$

Structural Steel (ASTM A709 Grade 50)

$f_s = 27,000 \text{ psi}$, $f_y = 50,000 \text{ psi}$

Structural Steel (ASTM A709 Grade 50W)

$f_s = 27,000 \text{ psi}$, $f_y = 50,000 \text{ psi}$

Design Procedure:

Moments and shears by "Variable I" analysis:
use computer program.

Trial sections from "Preliminary analysis":

Combination of web depth, flanges and length of plates used shall be the most economical section available with depths compatible with vertical clearance requirements.

Web depths in 6" increments are preferred, however other increments may be used when required by the Design Layout.
(See Structural Project Manager).

Flanges:

Minimum flange dimensions = 3/4" x 12" (*).

Increments:

Thickness	1/8"
Width	1"

Maximum flange dimensions:

(Reference AASHTO - Table 10.32.1A)

maximum thickness = 4"

Note:

It is preferred office practice to maintain the same flange thickness at as many locations as practical. This can be accomplished by varying the flange width.

(*) For shipping and erection purposes, minimum width of both compression and tension flanges shall not be less than $L/85$ where L is the shipping length of the girder. This limitation is for preventing out-of-plane distortion of the girder.

Webs:

Web dimensions:

(Reference AASHTO - Article 10.34 & 10.48)

ASTM A709 Grade 36 = 3/8" minimum thickness for curved girders and for continuous straight girders.

ASTM A709 Grade 50W = 3/8" minimum thickness.

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Design Assumptions & Procedures (Cont.)

Design

Fatigue Stress:

AASHTO - Article 10.3 Case I, Case II or Case III

Case I

Bridges with the truck traffic count of 2500 or more vehicles per day. (One direction)

Case II

Bridges with traffic count of 750 or more vehicles per day, and less than 2500 truck traffic count (One direction) per day.

Case III

Bridges with traffic count of less than 750 vehicles per day, except when live loading is H20 or greater.

No Fatigue:

Bridges with traffic count of less than 75 vehicles per day.

**Total Capacity of Exterior Girders:
(Dead Load and Live Load)**

In no case shall an exterior girder have less carrying capacity than an interior girder.

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Design Assumption & Procedure (Cont.)

Design

Camber and Haunching

Prestressed Panel Section:

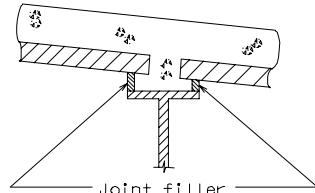
Steel girders shall be cambered when using P/S Panels.

Joint Filler:

3/4" min. thru 2" max. thickness
except use 1/4" min. over
splice plate.

1-1/2" standard width
3/4" min. width at splice plates.

When joint filler over a splice plate
is less than 1/2" thick then joint
filler width shall be the same as panel
on splice or 1-1/2" max.



The same thickness of joint filler material shall be used under any one edge of any panel except at splices, and the maximum change in thickness between adjacent panels shall be 1/4" to correct for variations from girder camber diagram.

Girder Camber:

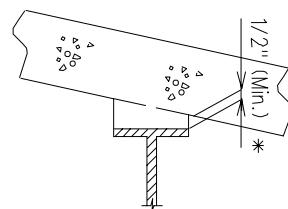
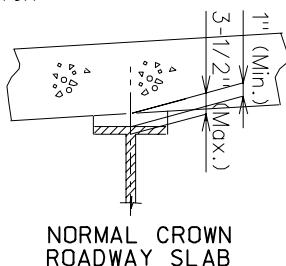
See "Details" of this section for camber diagram and continuous slab haunch details.

Dead Load Deflection:

Compute at 1/4 points for bridges with spans less than 75', at 1/10 points for spans 75' and over.

Cast-In-Place Section:

Slab Haunch



SUPERELEVATED
SLAB

* 1/2" minimum edge clearance except over splice plates use 1/4" min.
Maximum haunch limit of 3-1/2" may be maintained by changing girder slope at field splices or cambering girders.

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Design Assumption & Procedure (Cont.)

Design

Web, Web Stiffeners, Flanges and Bars

Design Criteria:

AASHTO - Articles 10.34.4, 10.48.5 & 10.48.8

Attention:

The maximum spacing of the first intermediate stiffener at the simple support end of a girder (straight girder) is limited to one and one half of the web depth (1.5D).

The maximum spacing of intermediate transverse web stiffeners shall be three times the web depth (3.0D). (Where D = clear, unsupported distance between flange components).

Design Economy:

In accordance with the specifications, stiffeners may be omitted when indicated by design and economy.

Basis for economic comparison of designs:

Cost comparisons can be based on current average bid prices that may be obtained from Structural Project Manager for comparable bridges.

In order to omit intermediate stiffeners, a web thickness increase of 1/16" is usually economical. It will usually be economical to eliminate transverse stiffeners for shallow girders (36" to 42").

Bars:

Small plate materials of any thickness and up to 8" in width must be ordered by fabricators as bars in 20 ton lots for each size. Since premium prices must be paid for small orders of odd sizes, the number of different sizes should be reduced to a minimum in designing and detailing bearing stiffener plates up to 8" in width.

Design Assumptions & Procedures (Cont.)**Design****Horizontal Curved Girders Design Procedures (*)**

Curved plate girders are to be designed using load factor design criteria. The 1980 AASHTO Guide Specifications for Horizontally Curved Highway Bridges as revised by Interim Specifications for Bridges 1981, 1982, 1984, 1985 and 1986 is to be applied with the USS Highway Structure Design Handbook (*) V-Load method to be used as a working example.

The following procedure may be followed to determine the required cross-section for any system of curved girders with skews less than 46°. See Cigar Manual procedure for skews 46° and greater and check moments in intermediate diaphragms.

1. Determine the primary moments by the same procedures as for a system of straight girders, using the developed lengths of the curved girders.
2. From primary moments, compute shear loads, V , using the formula:

$$V = \frac{\sum M}{\text{Coeff.} \times K} \quad \begin{aligned} V &= \text{Shear loads.} \\ M &= \text{Primary moments.} \end{aligned}$$

$$K = \frac{RD}{d}$$

R = Radius of curvature (outside girder).

D = Radial distance between inside and outside girders.

d = Distance between diaphragms measured along axis of outside girder.

The following coefficients may be applied to "K" for the various multiple-girder systems with equal spacing between girders.

SYSTEM	COEFFICIENT FRACTION	COEFFICIENT DECIMAL
2 girders	1	1.00
3 girders	1	1.00
4 girders	10/9	1.11
5 girders	5/4	1.25
6 girders	7/5	1.40
7 girders	14/9	1.56
8 girders	12/7	1.72
9 girders	15/8	1.88
10 girders	165/81	2.04

3. Compute V-Load moments

* Reference: USS "Highway Structures Design Handbook" 1965 Edition. (Updated 1986 Volume II Section 6) developed by Richardson, Gordon and Associates in cooperation with Dr. John Scalzi is to be used as a working example.

Design Assumptions & Procedures (Cont.)

Design

Horizontally Curved Girders Design Procedure (Cont.)

4. Compute lateral bending moments using the approximate formula:

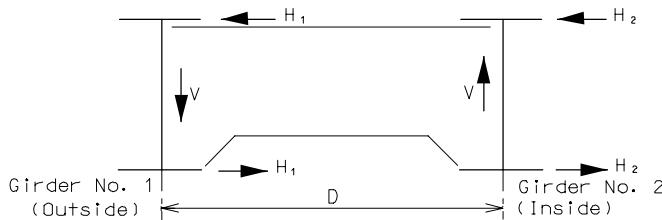
$$M_L = \frac{Hd}{10} = \frac{Md^2}{10Rh}$$

M_L = Lateral bending moment

H = The H values are approximately equal to the reactions at the supports.

h = Depth of girder between centers of gravity of flanges.

M = Primary moment + Secondary moment.



5. Determine cross-section required to provide for vertical and lateral forces computed under Items 1 to 4 inclusive.

As with any statically indeterminate system it is necessary to make an initial assumption of the required cross-sections and to repeat the calculations one or more times to obtain reasonable agreement between the assumed and required sections.

6. The non-compact section requirement that $F_y > (f_b + f_w)$ is to be applied to all sections with the tension flange $F_y > (f_b + f_w)$ and the compression flange as $F_y (1-3\lambda^2) > (f_b + f_w)$ to insure conservative design.

In computing λ , use λ to be actual diaphragm spacing for compression and tension stresses.

The value of f_w is to be selected as plus or minus in the equations for p_v to give the worst possible case.

Design Assumptions & Procedures (Cont.)**Design****Horizontally Curved Girders Design Procedure (Cont.)****Design and Detail Guides****1. Economic Arrangement of Spans and Depth-to-Spans Ratios**

Where there is flexibility in span arrangement, the same guides that apply to economic arrangement of straight girders are equally applicable to curved girders. Similarly the rules used to establish depth-to-span ratios for straight girders usually will apply to curved girders.

2. Spacing of Girders

Spacing depends on the arrangements of diaphragms and bracing. In general, however, it will be found that the most economical arrangement for straight girders will accord very well with the best arrangement for a system of curved girders. The effect of curvature increases in proportion to the square of the span length and decreases in proportion to the radius of curvature and the spacing of girders.

3. Arrangement and Spacing of Diaphragms

The diaphragms shall be placed radially, with a maximum spacing of 15'-0" (See this Section, page 3.2-4). In order to minimize lateral bending of the girder flanges, the flanges should be as wide as practical.

Sway frame bracing is selected for curved girder system, by same methods as for straight girders. (See this section, page 3.3-1)

4. Effect of Lateral Bracing

Provision for lateral loading on curved girders may be made in a similar manner as for straight bridges. If lateral bracing is used in a system of curved girders, the forces resulting from the radial components of flange stress may be carried partially or entirely by the bracing system; when both diaphragms and lateral bracing are used, radial reaction components may be divided between the two systems.

Design Assumptions & Procedures (Cont.)**Design****Horizontally Curved Girders Design Procedure (Cont.)****Design and Detail Guides (Cont.)****5. Approximate Estimate of Curvature**

The following formula may be used in making preliminary approximations of the effect of curvature:

$$P = 10.5 \times \frac{(1+r)(L')^2}{R_2 D} \quad \text{Note: For "r" refer to paragraph No. 7}$$
$$r = \frac{(R_2)^2}{(R_1)^2} \times \left(\frac{\text{Inside girder loading}}{\text{Outside girder loading}} \right) (*)$$

* May be omitted if supports are on radial lines.

P = % increase in positive moment due to effect of curvature.

R₂ = Radius of inside girder.

R₁ = Radius of outside girder.

L' = Distance between points of contraflexure in any positive moment area.

D = Spacing between inside and outside girders.

In the above form, the formula applies to a two-girder system, but it may be modified by reference to the table of coefficients for multiple-girder systems shown on page 1.1-5 of this section.

The formula applies particularly to positive moment, but for preliminary approximation it may be assumed that the curvature effect on negative moments will be about the same.

6. Design of Diaphragms and Connections

Where the degree of curvature is equal to or under 1°- 30' and when spans are equal to or under 75'-0" in length, the diaphragm and connections shall be the same as for Bridges with straight girders. Where the degree of curvature is over 1°- 30' to 3° or with a span length of more than 75'-0", the diaphragm must be attached to the tension flange (See details this Section). Where the degree of curvature is over 3°, a special design will be required for connection of intermediate diaphragms to flanges.

The maximum allowable diaphragm spacing is 15'-0", regardless of the amount of curvature, or span lengths.

Design Assumptions & Procedures (Cont.)

Design

Horizontally Curved Girders Design Procedure (Cont.)

Design and Detail Guides (Cont.)

6. Design of Diaphragms and connections (Cont.)

The following applies to those bridges where the special design is to be considered:

Since diaphragm moments due to effect of curvature are a function of the radial component of flange stress, they are directly proportional to the vertical bending moment in the girders.

For exterior girders the moment in the diaphragm equals $M \times d/R$, in which M = vertical bending moment in girder for any particular condition of loading; d = diaphragm spacing; R = Radius of curvature of girder.

For negative moment over the support, the M value used in this equation should be the average moment between a point at the support and a point at the first adjacent diaphragm.

Diaphragm connections may be made directly to the flanges of the girders or through stiffeners, provided details are arranged to adequately transfer radial components of flange stress into the diaphragms.

7. Supports positioned other than on radial lines.

If field conditions permit, the most orderly arrangement for curved girders will be attained by placing the supports on radial lines.

It may be necessary to treat each line of girders independently, first finding the direct loading moments and then correcting for curvature by applying the separate V-loads.

8. Transverse stiffeners

The maximum transverse stiffener spacing for curved plate girders is D , the web height.

Transverse stiffeners should be placed along the girder length only as far as required by design.

The maximum spacing of the first transverse stiffener at the simple support end of a curved plate girder is $D/2$.

Heat Curved Girders

Reference:

AASHTO - Article 10.5

Limit radius of heat curved girders according to AASHTO Article 10.15.

Where the distance between field splices of curved girders exceeds that given by the following formula, a special note shall be placed on the plans.

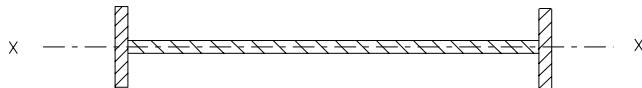
$$L = \sqrt{\frac{0.667 \times f_s \times S_M}{W}} \quad (*)$$

Where L = Allowable distance between field splices, in feet.

f_s = Allowable f_s of flange steel, in psi. e.g. use 20,000 psi for Grade 36 steel.

W = Weight of girder (flanges and web), in pounds per foot.

S_M = Section Modulus of girder about $x-x$ axis as shown, in inches cubed.



Note: If flanges are of different sizes, use smaller Section Modulus.

See Structural Project Manager for allowable overstress.

* Derivation

Positive moment at centerline, Mom. = $\frac{W L^2}{8} \times 12$

$$f_s = \frac{\text{Mom.}}{S_M}$$

Substitute mom. in f_s equation.

$$\therefore f_s = \frac{W L^2 \times 12}{8 \times S_M}$$

solve for L

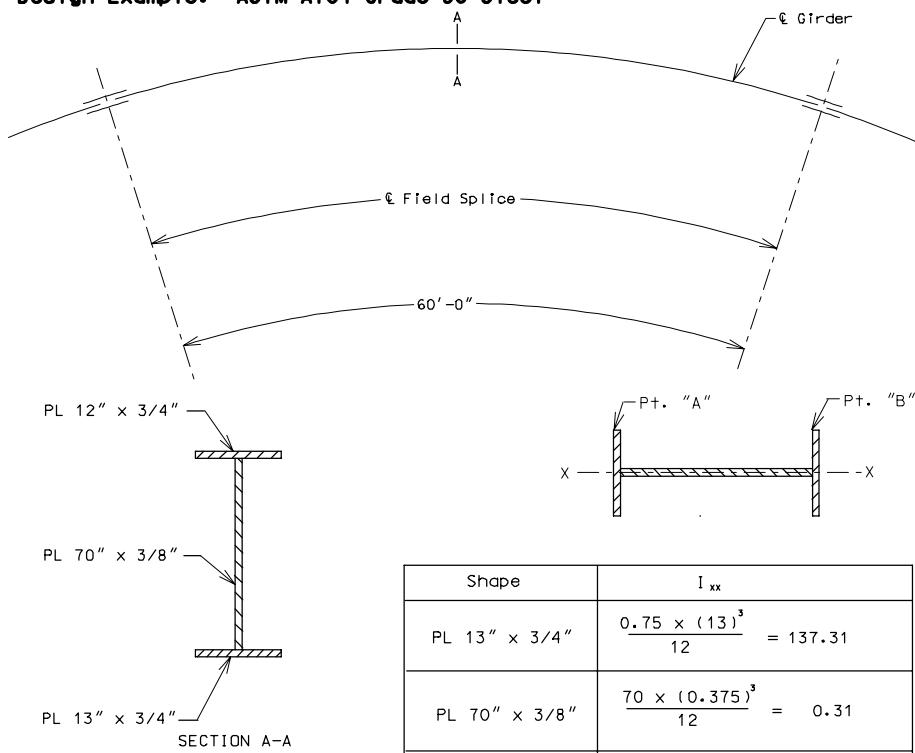
$$\therefore L = \sqrt{\frac{8 f_s \times S_M}{12 W}}$$

Design Assumptions & Procedures (Cont.)

Heat Curved Girders (Cont.)

Design Example: ASTM A704 Grade 36 Steel

Design



Weight per Foot of Girder	
PL 12" x 3/4"	= 30.6 lbs./ft.
PL 70" x 3/8"	= 89.3 lbs./ft.
PL 13" x 3/4"	= 33.2 lbs./ft.
Total	= 153.1 lbs./ft.

Shape	I_{xx}
PL 13" x 3/4"	$\frac{0.75 \times (13)^3}{12} = 137.31$
PL 70" x 3/8"	$\frac{70 \times (0.375)^3}{12} = 0.31$
PL 12" x 3/4"	$\frac{0.75 \times (12)^3}{12} = 108.00$
Total	$I_{xx} = 245.62 \text{ In.}^4$

$$SM_A = I/C = 245.62/6.5 = 37.79 \text{ In.}^3$$

$$SM_B = I/C = 245.62/6 = 40.94 \text{ In.}^3$$

From Formula:

$$L = \sqrt{\frac{0.667 \times f_s \times SM}{W}} = \sqrt{\frac{0.667 \times 20,000 \times 37.79}{153.1}} = 57.38' \quad \text{Use } 57.5'$$

57'-6" < 60'-0", Therefore, Special Note required.

Special Note:

Heat curving of girders (Identify) (*) will not be allowed while in the horizontal position.

* Complete underlined portion as required.

Design Assumptions & Procedures (Cont.)

Design

Preliminary Analysis

Design Procedure

Maximum Plate Lengths:

80 feet. See Structural Project Manager for use of longer lengths up to 85' for ASTM A709 Grade 50 or ASTM A709 Grade 50W and 100' for ASTM A709 Grade 36.

Minimum Plate Lengths:

10 feet. Shop flange splices should be eliminated and extra plate material used when economy indicates and span lengths permit.

Cost of Flange Splices:

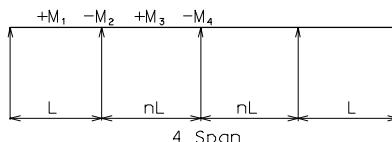
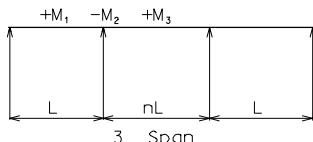
\$275 per flange minimum thru 1-1/8" plates. 1-1/4"± plates - \$330 per flange (Add \$55 for each additional 1/4" in plate thickness). (Includes Welding, Inspection, etc.).

Plate Material \$0.35 per pound.

Preliminary Analysis:

(1) Compute moments from influence lines on basis of "Constant I" analysis and apply the following percentage increase or decrease to non-composite dead load moments.

References may be used in lieu of the above.



$$n = 1.2 \text{ to } 1.5$$

+M ₁	-5%
-M ₂	+15%
+M ₃	-15%

$$n = 1.2 \text{ to } 1.5$$

+M ₁	-5%
-M ₂	+15%
+M ₃	-15%
-M ₄	+15%

(2) Determine trial sections and plot a rough moment curve to determine location of flange plate cutoffs, if any.

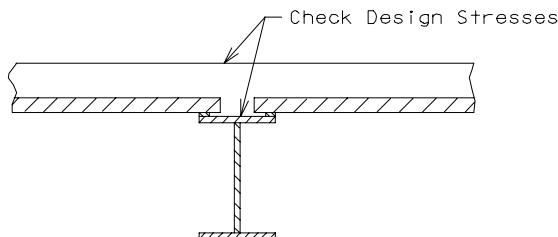
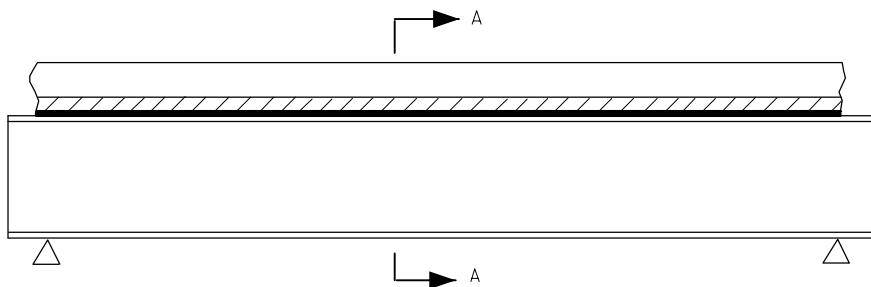
(3) Complete analysis by using computer programs to obtain actual moments and stresses.

Design Assumptions & Procedures (Cont.)

Design

Design Stress Investigation for Positive Moment Area of Plate Girder structures

The design stresses are to be checked at the top of flange (steel) and the top of concrete slab in the composable area of Plate Girder Structures to insure that they are within the allowable stresses.



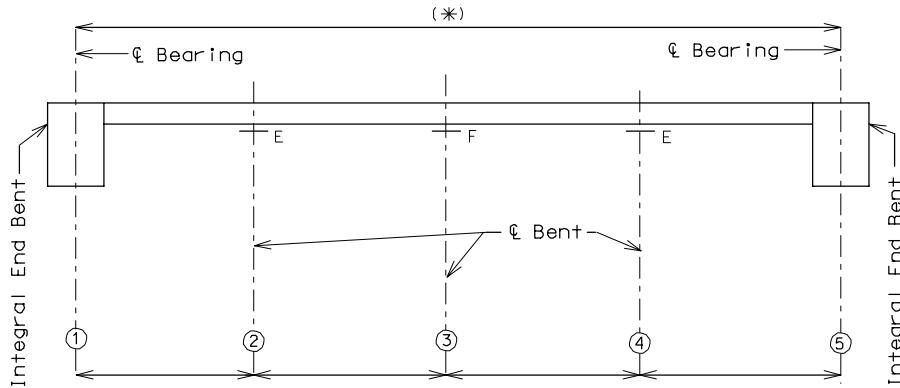
SECTION A-A

Design Assumptions & Procedures (Cont.)

Design

Structure Length

Typical Continuous Steel Structures - Integral End Bents:



(*) Maximum length from End Bent to End Bent = 500 feet.

Design Assumptions & Procedures (Cont.)**Design****Estimated Girder Depth**

Based on Three Spans With Ratio N = 1.3 ±

Continuous Plate Girders HS20 Loading Load Factor (ASTM A709 Grade 36 Steel)

Initial Estimate (Feet)	Girder Depths (*) (Inches)	Structure Depth (**) (Feet)
85 to 99	42	4.50
100 to 119	48	5.00
120 to 129	54	5.50
130 to 144	60	6.00
145 to 154	66	6.50
155 to 169	72	7.00
170 to 179	78	7.50
180 to 189	84	8.00
190 to 200	90	8.50

Continuous Plate Girders HS20 Loading Load Factor (ASTM A709 Grade 50 or ASTM A709 Grade 50W or Hybrid)

Initial Estimate (Feet)	Girder Depths (*) (Inches)	Structure Depth (**) (Feet)
85 to 104	42	4.50
105 to 124	48	5.00
125 to 134	54	5.50
135 to 144	60	6.00
145 to 159	66	6.50
160 to 174	72	7.00
175 to 184	78	7.50
185 to 194	84	8.00
195 to 204	90	8.50

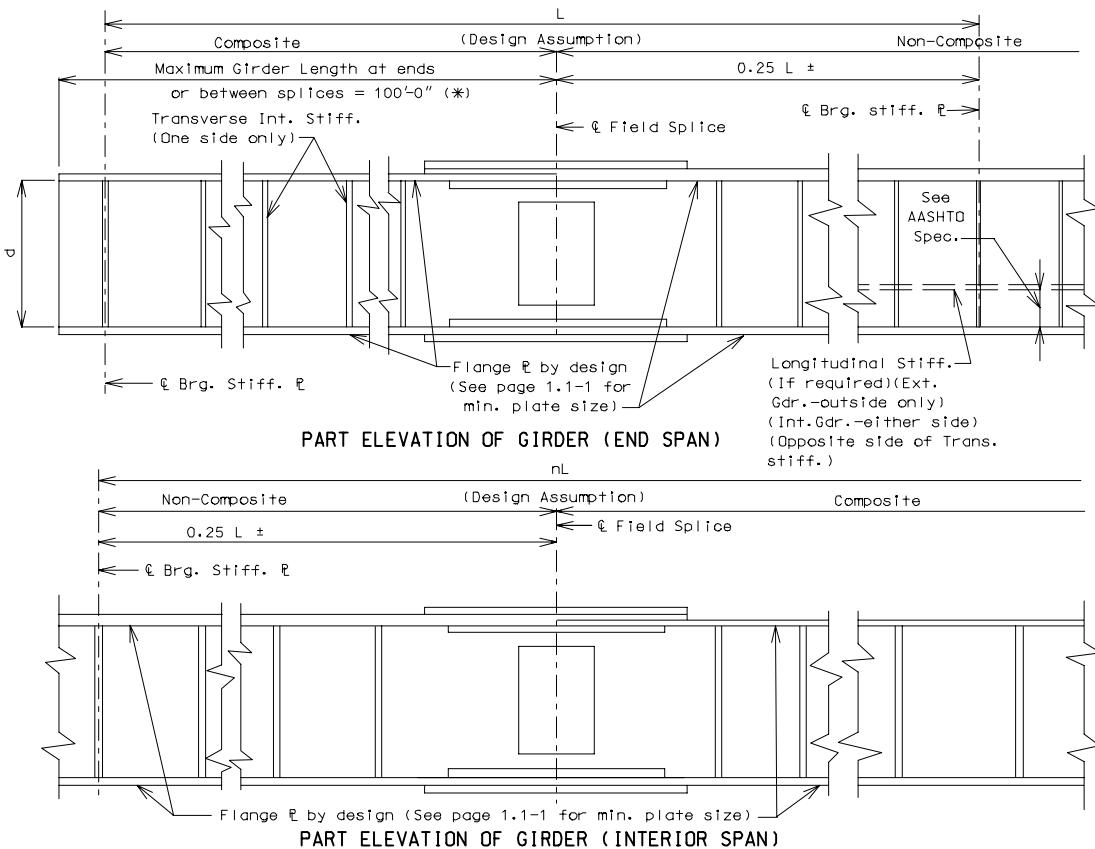
Trial steel plate girder depths use program BR109 to check designs and deflections. Web depths may be adjusted by two inch increments.

* Bethlehem steel economic study ($N = 1.3 \pm$). Bethlehem steel provided an economic study of multiple steel girder depths. The study indicated that cheaper designs are obtained by reducing the plate girder depths and reducing the number of stiffeners. The recommended initial estimates above are based on these designs.

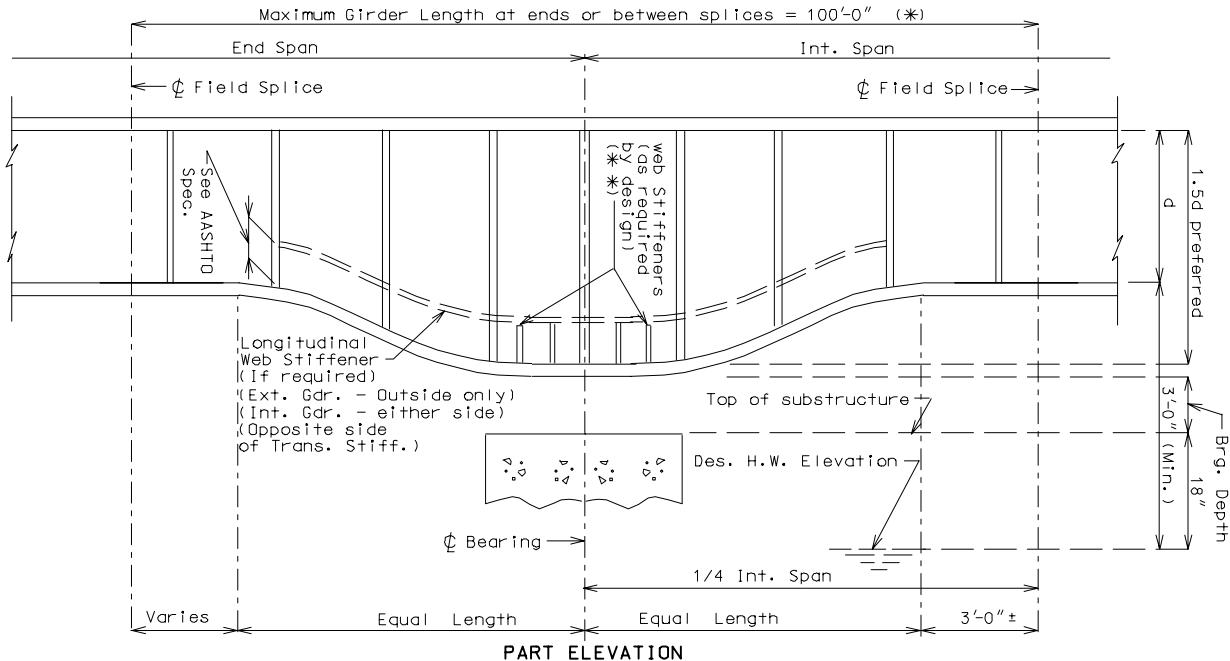
** Structure depth includes slab and haunch.

A general rule of thumb is to determine the minimum web thickness without stiffeners; then, use a web thickness of one-sixteenth inch less. Match MoDOT requirements for web increments of one-sixteenth inch only.

If two-span structures are used, a deeper web is required. A good estimate is to use six inches additional depth than the above tables for two-span structures.



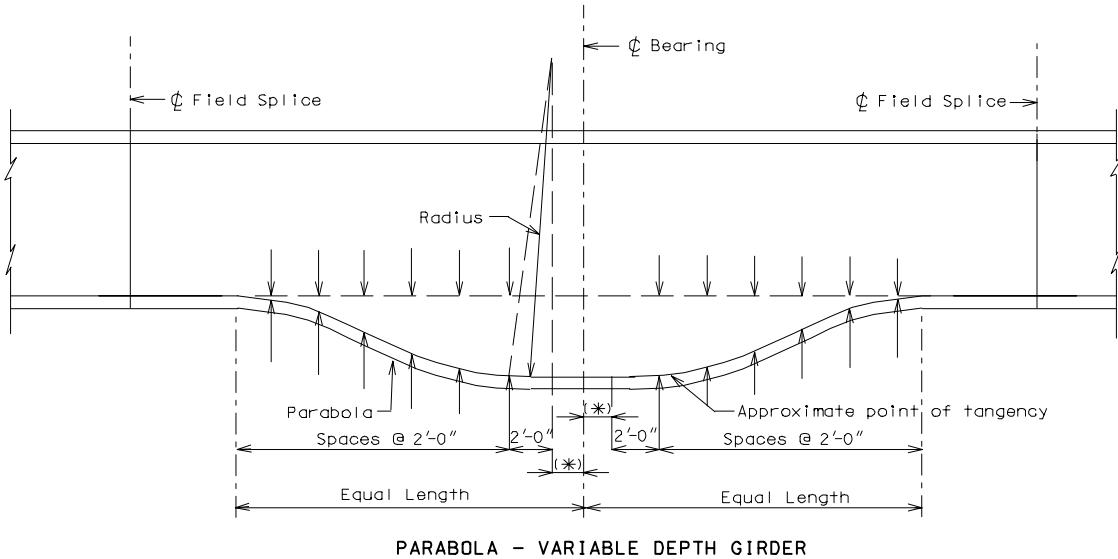
* See Structural Project Manager for approval to deviate from the Maximum Girder Length of plate girder sections.



Use Variable depth section only as specified on Design Layout Sheet. Consult the Structural Project Manager for consideration of constant depth section in lieu of variable depth section based on design references or structural adequacy.

* See Structural Project Manager for approval to deviate from the Maximum Girder Length of plate girder sections.

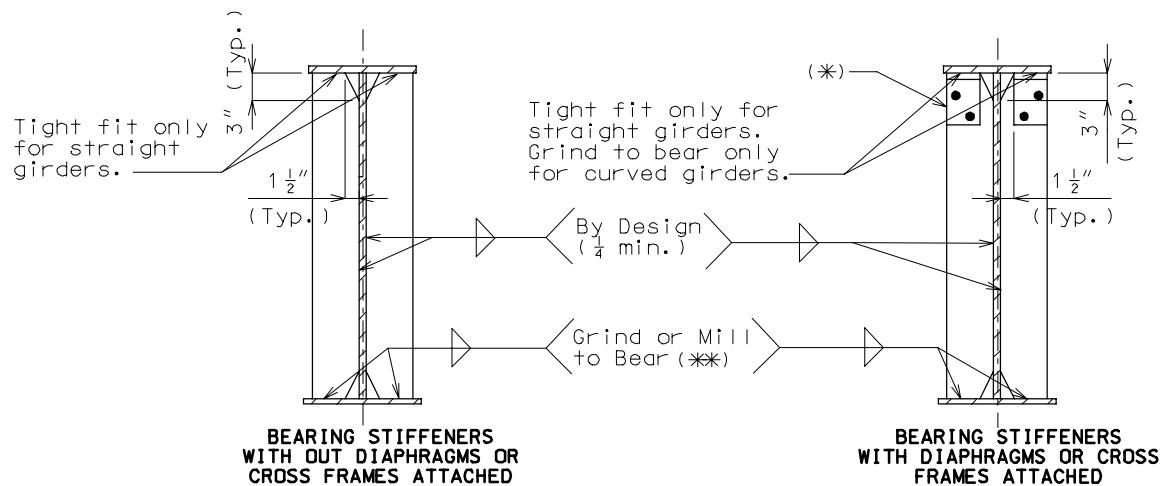
** See Design of Welded Structures by The James F. Lincoln Arc Welding Foundation, page 5.11-19.



(*) Use 12" except for girders having bottom flange plate over 1-1/2" in thickness, then use 18".

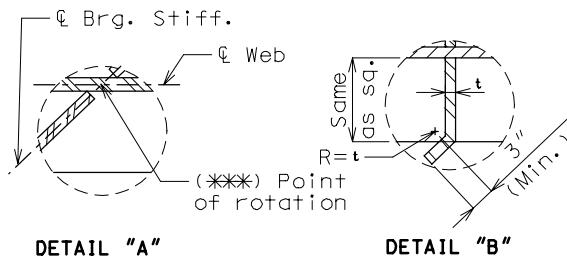
STIFFENER DETAILS - BEARING STIFFENERS

Details

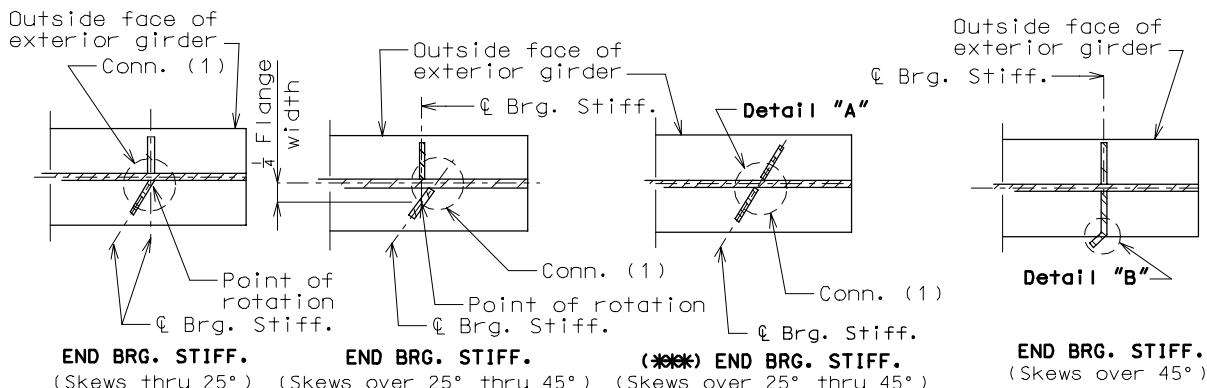


(*) Use angle as positive connection at flanges in accordance with AASHTO 10.19.3.2.
See Section 3.42 page 3.2-2 for connection angle details.

(**) Weld as positive connection at flanges in accordance with AASHTO 10.19.3.2.



Note:
Design according to AASHTO 10.34.6;
Hybrid Girders, article 10.40
Bearing pressure on stiffeners shall
be figured at the bottom flange.



TYPICAL DETAILS LOCATING STIFFENER PLATES

(***) Rotate about centerline of web when a finger plate expansion device is required.

(1) See this section, page 2.1-4.

Bearing stiffeners shall extend to within 1/2" of the edge of the bottom flange plate.

Bearing area of end bearing stiffener plate for skews over 45° must at least equal that of specified plate.

Make stiffener on both sides of web for skews thru 45° same size as the larger except in cases where overhang would be produced. This does not apply to end bearing stiffener for skews over 45°.

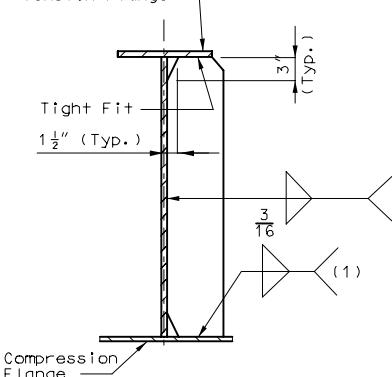
Width of plates shall be increased as required by 1/2" increments. Thickness of plates shall be increased as required by 1/8" increments, 1/2" minimum thickness.

Stiffener Details (cont.)

Int. Web Stiffeners and Int. Diaphragms Connection Plates

(Welding Details)

Tension Flange



**INT. WEB STIFFENER
(ONE SIDE ONLY) VARIABLE FLANGE WIDTH**

- (1) Compression flange only.
See Section 4H for appropriate note also for web stiff. notes.

Transverse stiffeners shall be used on inside face of exterior girders and in successive alignment along either side of interior girders.

Longitudinal stiffeners shall be used on outside face of exterior girders and in successive alignment along either side of interior girders.

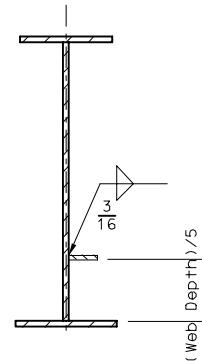
Top and bottom tension or compression flanges should be shown on the "Elevation of Girder" Detail on plans.

See AASHTO - Article 10.34.4 for size and spacing of web stiffeners.

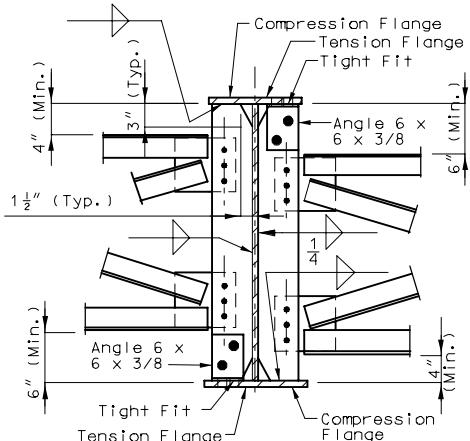
Note:

The two 3/4"Ø H.S. Bolts that connect the 6 x 6 x 3/8 angle to the top flange shall be placed so the nut is on the inside of flange toward the web.

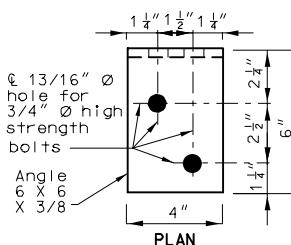
Apply AASHTO 10.34.1 which permits no reduction in section if net area is greater than 85% of gross area.



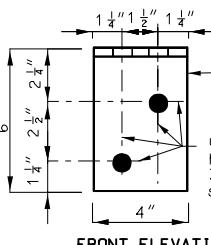
**LONGITUDINAL WEB STIFFENER
(ONE SIDE ONLY)**



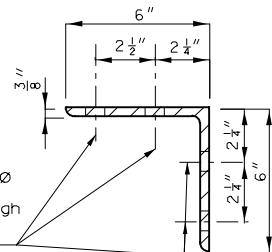
INT. DIAPH. CONNECTION PLATE
(Includes web stiffeners used as connection plates.)



PLAN

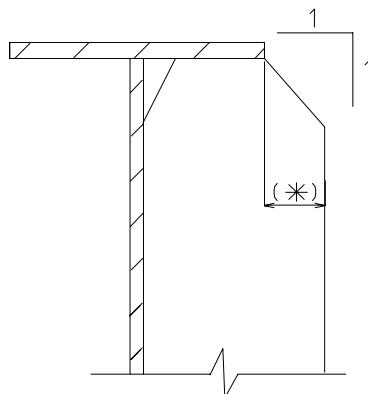


FRONT ELEVATION



SECTION THRU ANGLE

DETAIL OF FLANGE CONNECTION ANGLE

**DETAILS THRU BEVEL PLATE FOR INT. WEB STIFF.,
BRG. STIFF. AND INT. DIAPH. Conn. Plates.**

(*) When dimension exceeds 1/2", bevel stiffener plate.

Note:

For intermediate web stiffener plate and intermediate diaphragm connection plate, use 1/2" minimum thickness for all curved and straight girders.

Use 5-1/2" minimum width stiffener plate for 12" top flange or greater.

Width of plate shall be increased as required by 1/2" increments. Thickness of plates shall be increased as required by 1/8" increments when required thickness exceeds 1/2".

Bridge Manual

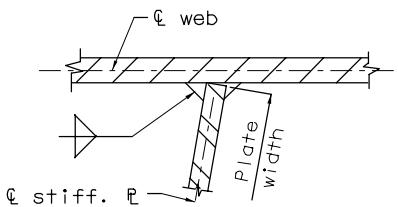
Welded Plate Girders - Section 3.42

Page: 2.1-4

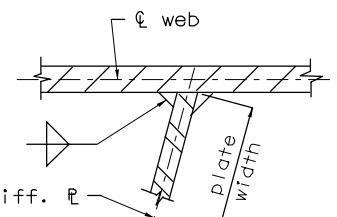
Stiffener Details (cont.)

Details

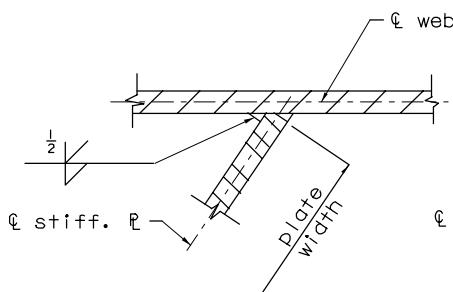
Bearing Stiffeners - Welding Details (skewed)



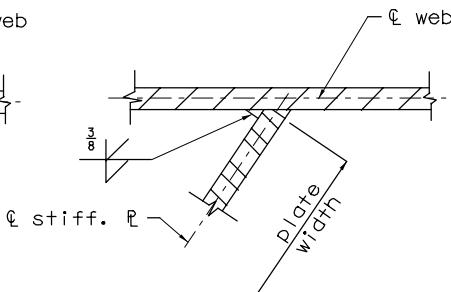
CONN. "A"



CONN. "B"



CONN. "C"



CONN. "D"

Attention Detailer:

Show detail on plans similar to conn. "A" for Int. Diaph. conn. with skews thru 20°.

Skew Angle	Stiffener Connection					
	3/8	1/2	5/8	3/4	7/8	1
0° thru 5°	A	A	A	A	A	A
6° thru 10°	A	A	A	A	B	B
11° thru 15°	A	A	B	B	B	B
16° thru 20°	A	B	B	B	B	B
21° thru 25°	A	B	B	B	B	B
26° thru 30°	A	B	B	B	B	B
31° thru 35°	D	C	C	C	C	C
36° thru 40°	D	C	C	C	C	C
41° thru 45°	D	C	C	C	C	C

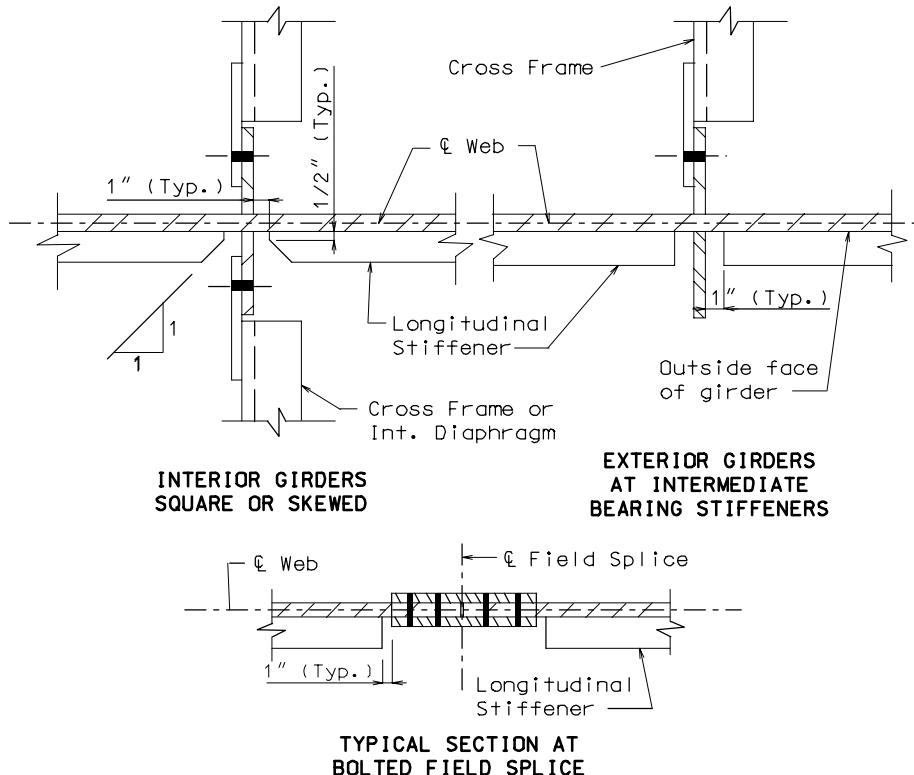
Stiffener Details (cont.)
Longitudinal Stiffener Details**Plate Girder**

When longitudinal stiffeners are required they shall be used on the outside of exterior girders and on either side of interior girders.

The placement of longitudinal stiffeners may interfere with bolting the diaphragm or cross frame in place. Should this occur, it will be necessary to clip the longitudinal stiffeners as shown below.

Also, when lateral bracing is required, place the longitudinal stiffener on the opposite side of girder.

The appropriate details shown below shall be modified if required and place on the design plans.



See Section 4 H for proper note.

2.2 Field Flange Splice - Bolted

General

Splices shall be designed using the Service Load Design Method and in accordance with AASHTO Articles 10.18, 10.24 and 10.32 except as noted.

Splices shall be designed to develop 100% of the flange strength by the flange splice plate strength. When the flange section or steel grade changes at a splice, the smaller flange strength shall be used to design the splice. ASTM A709 Grade 36 flange splice plates shall be used for all cases regardless of flange steel grade except when weathering steel flanges are used, splice plates shall then match the grade used in the flanges.

Minimum Yield Strength (F_y) and Minimum Tensile Strength (F_u)

ASTM A709 Grade 36	$F_y = 36$ ksi	$F_u = 58$ ksi
ASTM A709 Grade 50	$F_y = 50$ ksi	$F_u = 65$ ksi
ASTM A709 Grade 50W	$F_y = 50$ ksi	$F_u = 70$ ksi

Allowable Steel Stresses (F_t)

Allowable stresses are determined by AASHTO Table 10.32.1A.

Allowable tensile stress	$F_t = 0.55 \times F_y$
ASTM A709 Grade 36	$F_t = 20$ ksi
ASTM A709 Grade 50	$F_t = 27$ ksi
ASTM A709 Grade 50W	$F_t = 27$ ksi

Allowable Bolt Stresses

Splices shall be designed as slip critical connections with Class B surface preparation and oversized holes. Although standard holes are used in the fabrication of flange splices, designing the splices for oversize holes allows for some fabrication and erection tolerances. All splice bolts shall be 7/8" diameter ASTM A325 high strength bolts.

AASHTO Table 10.32.3C specifies $F_s = 19$ ksi for a class B slip-critical connection. Tables shown in this manual are based on 19 ksi that should also be used to design splices not listed in the table.

Although slip-critical connections are theoretically not subject to shear and bearing, they must be capable of resisting these stresses in the event of an overload that causes slip to occur. The allowable shear stress per bolt (F_v) for bearing is 19 ksi with the threads included and $1.25 \times 19 = 23.75$ ksi for threads not included.

Flange Strength

The flange strength shall be determined by multiplying the allowable stress of the flange by the area of the flange. The area of the flange shall be taken as the gross area of the flange, except that if more than 15 percent of each flange area is removed, that amount

removed in excess of 15 percent shall be deducted from the gross area. Bolt holes are considered to be 1" diameter for the purpose of determining flange area.

Splice Plate Strength

The splice plate strength shall be determined by multiplying the allowable stress of the splice plates by the area of the splice plates. The area of the splice plates shall be taken as the gross area of the splice plates, except that if more than 15 percent of the splice plate area is removed, that amount in excess of 15 percent shall be deducted from the gross area.

Two Row Splices

Splices with two rows of bolts are used with flanges 12 to 13 inches wide. The inner and outer plates may either be the same length or the inner plate may be shorter. This is the case if the end bolts in the splice are only needed to be in single shear. All other bolts will be in double shear. (See Figure 3.42.2.2-1)

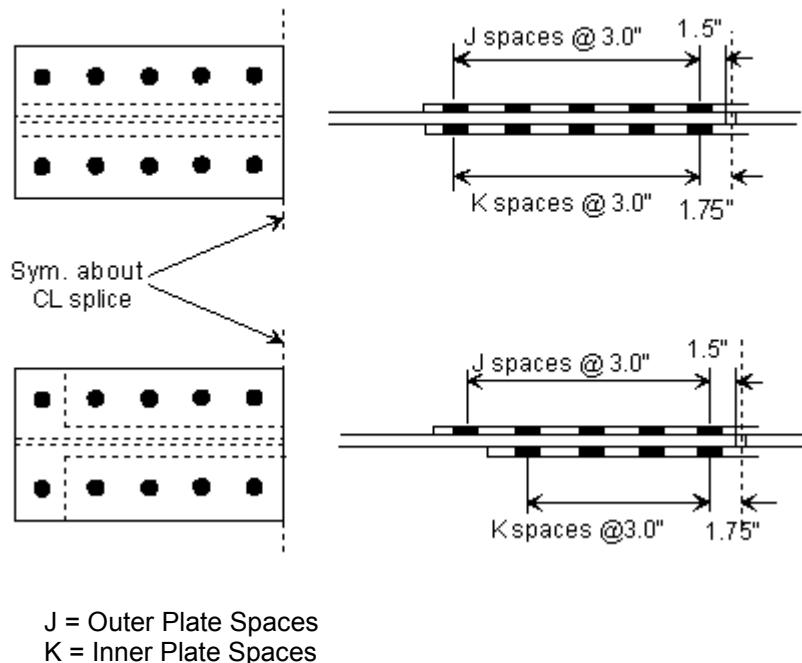


Figure 3.42.2.2-1

Four Row Splices

When the width of the flange being spliced is 14 inches or greater, four longitudinal rows of bolts are used. Three variations of the end bolts positioning may be used. In each of these variations, the last two bolts shall be located in the outer rows closest to the edge of the splice plate.

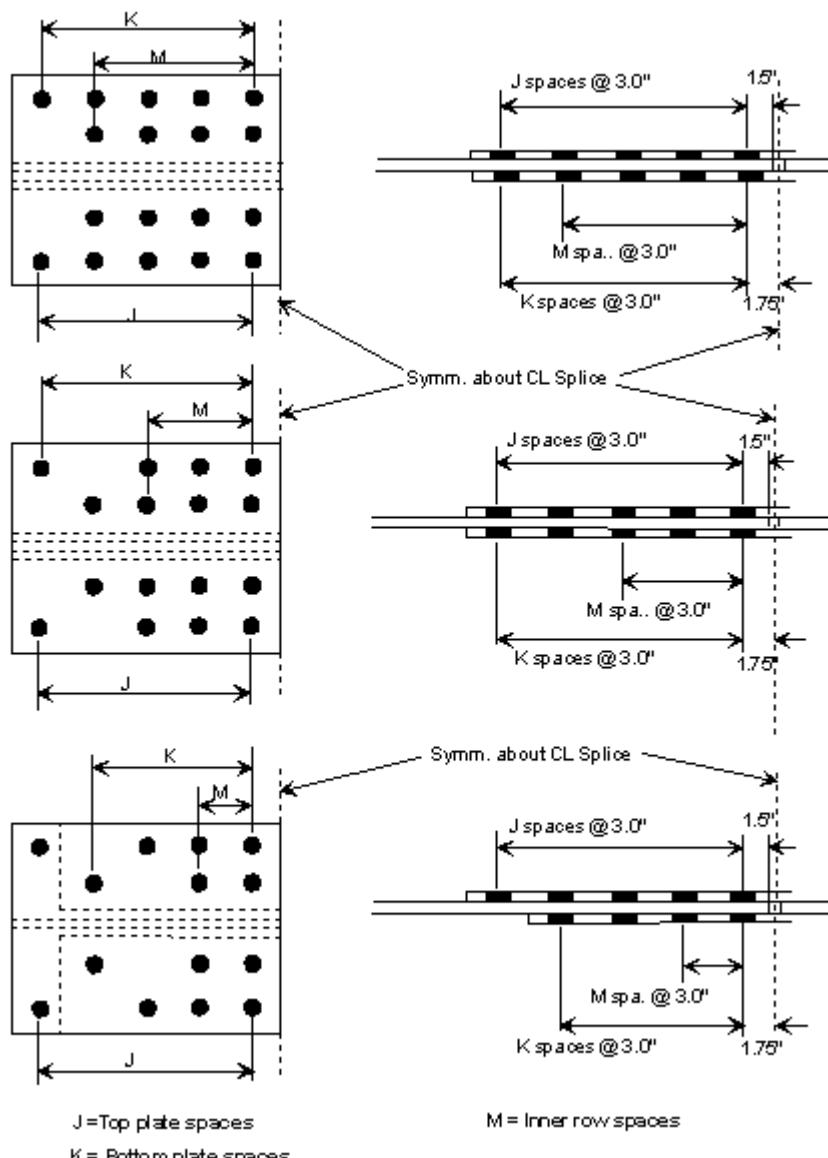


Figure 3.42.2.2-2

Flange Width Transitions

When the width of the flanges being spliced differs by more than 2", the larger flange shall be beveled as shown in Figure 3.42.2.2-3

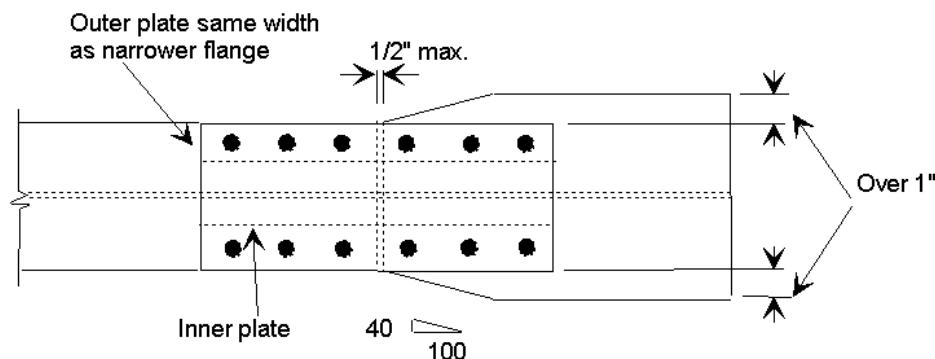


Figure 3.42.2.2-3

Weight of Splice

When calculating the weight of splice, the following simplified weights shall be used.

Weight of High-Strength bolts (diameter 7/8") = 0.95 lbs/bolt

Unit weight of Structural Steel = 490 lbs/ft³

Design Example

ASTM A709, Grade 36 Flange (12" x 1.125") and Flange Splice Plate

$$F_y = 36 \text{ ksi}, F_u = 58 \text{ ksi}$$

Allowable tensile stress for flange plate and splice plate

$$F_t = 0.55 \times F_y = 20 \text{ ksi}$$

Allowable nominal slip resistance per unit bolt area for High-Strength Bolts

$$F_s = 19 \text{ ksi}$$

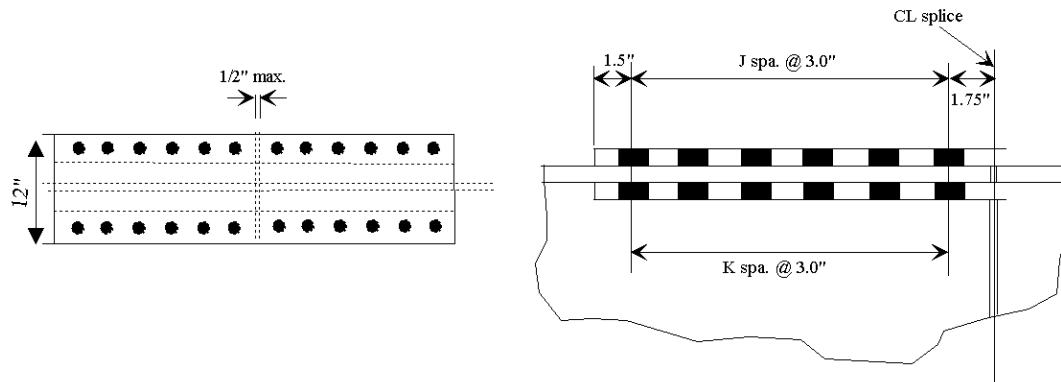


Figure 3.42.2.2-4

Flange Section Properties

Gross area of flange

- $A_g = 12'' \times 1.125'' = 13.5 \text{ in}^2$

Check of percent of hole area in flange

- $\% \text{ Holes} = [(2'')/(12'')](100\%) = 16.7\% > 15\%$
- Therefore, reduce A_g

Percent reduction of flange gross area

- $P_r = 16.7\% - 15\% = 1.7\%$

The reduced gross area of flange

- $A_{gr} = A_g (1 - P_r) = 13.5(1 - 0.017) = 13.27 \text{ in}^2$

Net width of flange

- $W_n = 12'' - (1 \times 2'') = 10''$

Net Area of flange

- $A_n = 10'' \times 1.125'' = 11.25 \text{ in}^2$ (AASHTO 10.16.14)

Flange Tensile Capacity

- Gross area capacity = $F_t \times A_{gr} = 20 \text{ ksi} \times 13.27 \text{ in}^2 = 265.4 \text{ kips}$
- Net area capacity = $0.5 \times F_u \times A_n = 0.5 \times 58 \text{ ksi} \times 11.25 \text{ in}^2 = 326.25 \text{ kips}$

265.4 kips CONTROLS

Bolt Design

Number of Bolts Needed

Single shear allowable bolt force for slip critical and for bearing connections

$$\bullet \quad P_{all} = \pi \left(\frac{0.875"}{2} \right)^2 (19.0 \text{ ksi}) = 11.43 \text{ kips}$$

The number of bolts required for the splice is determined by the controlling capacity of the flange plates and the number of bolt shear sections required.

$$\text{No. of shear sections required} = \frac{265.4}{11.43} = 23$$

Since 23 shear sections are needed for each side of the splice, we will use two rows of 6 bolts on each side. Since the bolts are in double shear a total of 24 shear sections is provided. (See Figure 3.42.2.2-4) In this situation the number of J spaces and K spaces are equal.

$$J = K = 5$$

The bolt capacity of the splice is

$$\bullet \quad P_{all} \times (\# \text{ Bolt Shear Sections}) = 11.43 \text{ kips} \times 24 = 274.32 \text{ kips}$$

274.32 kips > 265.4 kips, Therefore, bolt strength is OK!

Length of splice

$$\text{Inner and outer plate length} = (2 \times 5 \times 3.0") + 4(1.5") + 0.5" = 36.5"$$

The length of the splice needs to be checked in accordance with AASHTO Table 10.32.3B. A note states "In connections transmitting axial force whose length between extreme fasteners measured parallel to the line of force exceeds 50 inches", the allowable stress on bolts "shall be reduced 20 percent."

$$\text{Length between extreme fasteners} = 5 \times 3.0" = 15"$$

15 inches < 50 inches

Therefore, the assumed allowable bolt force is OK!

Splice Plate Design

Gross Section of Splice

Minimum required gross area of splice plate

$$\bullet \quad A_g(\text{Splice, Min.}) = A_g(\text{Flange}) = 13.27 \text{ in}^2$$
$$(t)(\text{width outer plate} + \text{width inner plates}) = 13.27$$
$$(t)(12 + 2 \times 5) = 13.27 \Rightarrow t = 0.6032 \Rightarrow \text{Try } t = 0.625"$$

Gross area of splice plates, A_{gp}

$$\bullet \quad A_{gp} = (12" \times 0.625") + 2(5") \times (0.625") = 13.75 \text{ in}^2$$

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Field Flange Splice - Bolted

Details

Net area of splice plates, A_{np}

$$\bullet \quad A_{np} = (10'' \times 0.625'') + (2 \times 4'' \times 0.625'') = 11.25 \text{ in}^2$$

Check the percentage of holes in splice plates

- % Holes = $(4 \times 1'') / (12'' + 2 \times 5'') \times 100\% = 18.2\% > 15\%$
- Therefore, reduce A_{gp}

Reduction for area of holes in excess of 15%, R_h

$$\bullet \quad R_h = 0.182 - 0.15 = 0.032$$

The reduced gross area of splice plates, A_{gr} (Splice), is the gross area of the plates minus the reduction due to the area of holes over 15%.

- $A_{gr} (\text{Splice}) = A_{gp} (1 - R_h) = 13.75 \times (1 - 0.032) = 13.31 \text{ in}^2$
- $A_{gr} (\text{Flange}) = A_g (1 - P_r) = 13.5 \times (1 - 0.017) = 13.27 \text{ in}^2$

13.31 in² > 13.27 in², Therefore, splice plates OK!

Plate thickness = 0.625 in

Outer plate width = 12 in

Inner plate width = 2 @ 5 in

Plate length = 36.5 in

Bearing Design Check

Allowable bearing on connected material is as follows.

AASHTO Table 10.32.3B

$$F_{p(\text{allow})} = 0.5 \frac{L_c F_u}{d} \leq F_u$$

$$F_{p(\text{allow})} = 0.5 \frac{(1'')(58 \text{ ksi})}{0.875''} = 33.14 \text{ ksi}$$

Where:

L_c = Clear distance between holes or between the holes and the end of the splice plate in the direction of the applied force in bearing

d = Diameter of bolt

Bearing on flange plate steel is

- $\frac{265.4 \text{ kips}}{(0.875'')(1.125'')(12 \text{ bolts})} = 22.47 \text{ ksi}$
- $22.47 \text{ ksi} < 33.14 \text{ ksi}$ Therefore,

Bearing on Flange plate is OK!

Bearing on splice plate steel is

- $\frac{265.4 \text{ kips}}{(0.875'')(0.625'')(2)(12 \text{ bolts})} = 20.22 \text{ ksi}$
- $20.22 \text{ ksi} < 33.14 \text{ ksi}$ Therefore,

Bearing on Splice plates is OK!

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Welded Plate Girders – Section 3.42

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Field Flange Splice - Bolted

Details

Weight of Splice

- Weight
 - = (24 bolts x 0.95 lb/bolt) + (36.5 x 0.625 x 12)(490 lb/ft³) +
(36.5 x 0.625 x 5 x 2)(490 lb/ft³)
 - = **165.1 lb/Splice**
 - (Includes outer and inner flange splice plates)

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Welded Plate Girders – Section 3.42

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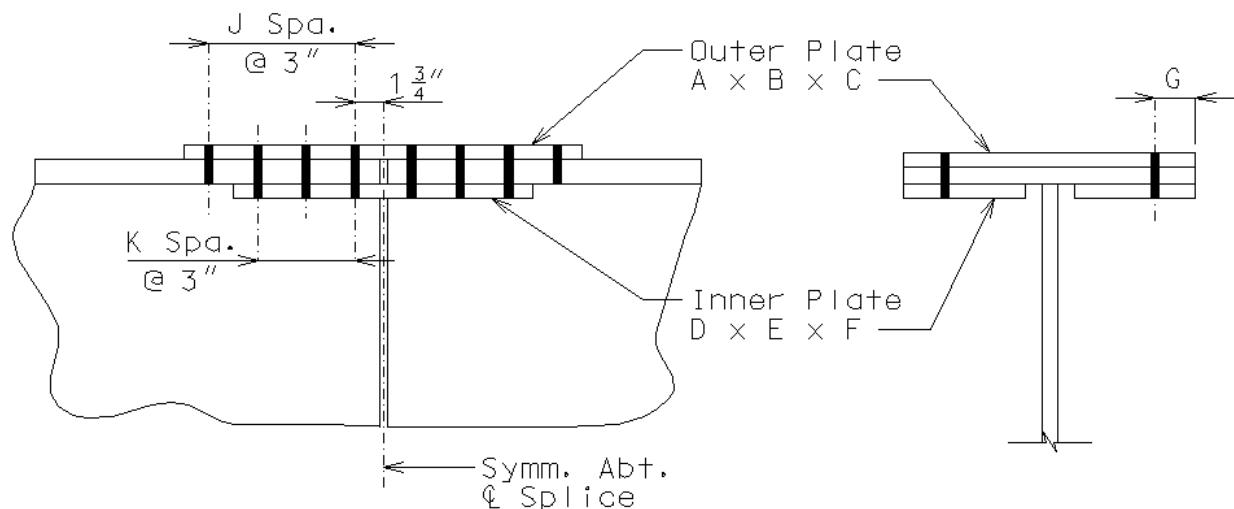
Field Flange Splice – Bolted

Details

Bolted Field Flange Splice Tables

FLANGE PLATE SIZE: 12" THRU 13" (2 ROWS OF BOLTS)

ASTM A709, Grade 36 Flanges, Grade 36 Splice



Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
12" x 3/4"	12	3/8	24.5	5	1/2	24.5	2.5	3	3	0	16	81.2
12" x 7/8"	12	1/2	30.5	5	1/2	30.5	2.5	4	4	0	20	114.1
12" x 1"	12	1/2	36.5	5	5/8	30.5	2.5	5	4	0	24	139.0
12" x 1-1/8"	12	5/8	36.5	5	5/8	36.5	2.5	5	5	0	24	165.1
12" x 1-1/4"	12	5/8	42.5	5	3/4	36.5	2.5	6	5	0	28	194.6
12" x 1-3/8"	12	3/4	48.5	5	3/4	42.5	2.5	7	6	0	32	244.6
12" x 1-1/2"	12	7/8	48.5	5	7/8	48.5	2.5	7	7	0	32	295.1
12" x 1-5/8"	12	7/8	54.5	5	1	48.5	2.5	8	7	0	36	334.0
12" x 1-3/4"	12	1	60.5	5	1	54.5	2.5	9	8	0	40	398.4
12" x 1-7/8"	12	1	60.5	5	1-1/8	60.5	2.5	9	9	0	40	436.9
12" x 2"	12	1-1/8	66.5	5	1-1/8	60.5	2.5	10	9	0	44	489.4
12" x 2-1/8"	12	1-1/8	66.5	5	1-1/4	66.5	2.5	10	10	0	44	532.1
12" x 2-1/4"	12	1-1/4	72.5	5	1-1/4	72.5	2.5	11	11	0	48	611.0
13" x 3/4"	13	3/8	30.5	5.5	1/2	24.5	2.75	4	3	0	20	99.4
13" x 7/8"	13	1/2	30.5	5.5	1/2	30.5	2.75	4	4	0	20	122.8
13" x 1"	13	1/2	36.5	5.5	5/8	36.5	2.75	5	5	0	24	161.2
13" x 1-1/8"	13	5/8	42.5	5.5	5/8	36.5	2.75	6	5	0	28	195.7
13" x 1-1/4"	13	5/8	48.5	5.5	3/4	42.5	2.75	7	6	0	32	241.6
13" x 1-3/8"	13	3/4	48.5	5.5	3/4	48.5	2.75	7	7	0	32	278.0
13" x 1-1/2"	13	7/8	54.5	5.5	7/8	48.5	2.75	8	7	0	36	342.4
13" x 1-5/8"	13	7/8	60.5	5.5	1	54.5	2.75	9	8	0	40	403.1
13" x 1-3/4"	13	1	60.5	5.5	1	60.5	2.75	9	9	0	40	449.7
13" x 1-7/8"	13	1	66.5	5.5	1-1/8	66.5	2.75	10	10	0	44	520.3
13" x 2"	13	1-1/8	72.5	5.5	1-1/8	66.5	2.75	11	10	0	48	579.6
13" x 2-1/8"	13	1-1/8	78.5	5.5	1-1/4	72.5	2.75	12	11	0	52	657.6
13" x 2-1/4"	13	1-1/4	78.5	5.5	1-1/4	78.5	2.75	12	12	0	52	717.2

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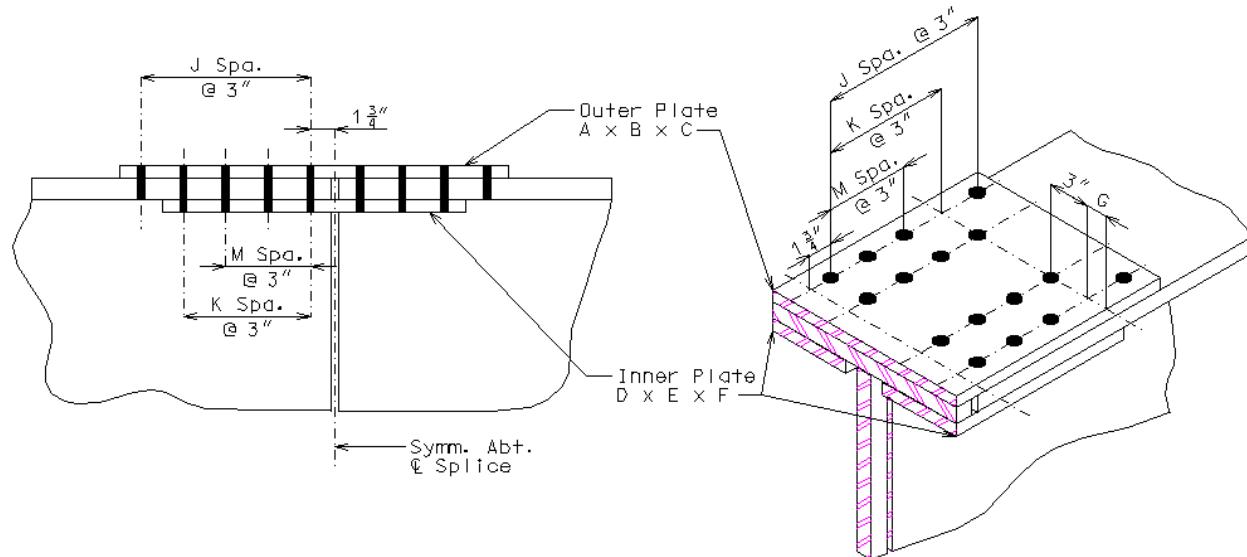
Page: 2.2-10

Field Flange Splice – Bolted

Details

FLANGE PLATE SIZE: 14" THRU 15" (4 ROWS OF BOLTS)

ASTM A709, Grade 36 Flanges, Grade 36 Splice



This table is not appropriate if P/S panel option is used because the edge distance "G" shall be equal to or greater than 2". See Section 3.40 page 3.3-2 for detail.

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
14" x 3/4"	14	3/8	18.5	6	1/2	18.5	1.5	2	2	1	20	78.0
14" x 7/8"	14	1/2	18.5	6	1/2	18.5	1.5	2	2	1	20	87.2
14" x 1"	14	1/2	24.5	6	5/8	24.5	1.5	3	3	1	24	123.5
14" x 1-1/8"	14	5/8	24.5	6	5/8	24.5	1.5	3	3	1	24	135.7
14" x 1-1/4"	14	5/8	24.5	6	3/4	24.5	1.5	3	3	2	28	149.9
14" x 1-3/8"	14	3/4	30.5	6	3/4	30.5	1.5	4	4	2	32	199.1
14" x 1-1/2"	14	7/8	30.5	6	7/8	30.5	1.5	4	4	2	32	227.2
14" x 1-5/8"	14	7/8	30.5	6	1	30.5	1.5	4	4	3	36	243.9
14" x 1-3/4"	14	1	36.5	6	1	36.5	1.5	5	5	3	40	307.1
14" x 1-7/8"	14	1	36.5	6	1-1/8	36.5	1.5	5	5	3	40	322.6
14" x 2"	14	1-1/8	36.5	6	1-1/8	36.5	1.5	5	5	4	44	344.5
14" x 2-1/8"	14	1-1/8	42.5	6	1-1/4	42.5	1.5	6	6	4	48	416.2
14" x 2-1/4"	14	1-1/4	42.5	6	1-1/4	42.5	1.5	6	6	4	48	437.3
15" x 3/4"	15	3/8	18.5	6.5	1/2	18.5	1.75	2	2	1	20	82.6
15" x 7/8"	15	1/2	24.5	6.5	1/2	24.5	1.75	3	3	1	24	120.1
15" x 1"	15	1/2	24.5	6.5	5/8	24.5	1.75	3	3	1	24	131.4
15" x 1-1/8"	15	5/8	30.5	6.5	5/8	24.5	1.75	4	3	1	28	164.1
15" x 1-1/4"	15	5/8	30.5	6.5	3/4	30.5	1.75	4	4	2	32	195.8
15" x 1-3/8"	15	3/4	30.5	6.5	3/4	30.5	1.75	4	4	2	32	212.0
15" x 1-1/2"	15	3/4	30.5	6.5	7/8	30.5	1.75	4	4	3	36	229.9
15" x 1-5/8"	15	7/8	36.5	6.5	7/8	36.5	1.75	5	5	3	40	291.6
15" x 1-3/4"	15	1	42.5	6.5	1	36.5	1.75	6	5	3	44	357.1
15" x 1-7/8"	15	1	36.5	6.5	1-1/8	36.5	1.75	5	5	4	44	348.4
15" x 2"	15	1-1/8	42.5	6.5	1-1/8	42.5	1.75	6	6	4	48	425.2
15" x 2-1/8"	15	1-1/8	48.5	6.5	1-1/4	42.5	1.75	7	6	4	52	477.3
15" x 2-1/4"	15	1-1/4	48.5	6.5	1-1/4	48.5	1.75	7	7	5	56	534.6

Bridge Manual

Welded Plate Girders – Section 3.42

Page: 2.2-11

Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 36 Flanges, Grade 36 Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
16" x 3/4"	16	3/8	18.5	7	1/2	18.5	2	2	2	1	20	87.2
16" x 7/8"	16	1/2	24.5	7	1/2	24.5	2	3	3	1	24	127.0
16" x 1"	16	1/2	30.5	7	5/8	24.5	2	4	3	1	28	156.6
16" x 1-1/8"	16	5/8	30.5	7	5/8	30.5	2	4	4	2	32	192.6
16" x 1-1/4"	16	5/8	30.5	7	3/4	30.5	2	4	4	2	32	207.7
16" x 1-3/8"	16	3/4	30.5	7	3/4	30.5	2	4	4	3	36	228.8
16" x 1-1/2"	16	3/4	36.5	7	7/8	36.5	2	5	5	3	40	289.0
16" x 1-5/8"	16	7/8	42.5	7	7/8	36.5	2	6	5	3	44	337.3
16" x 1-3/4"	16	1	42.5	7	1	42.5	2	6	6	4	48	407.1
16" x 1-7/8"	16	1	42.5	7	1	42.5	2	6	6	4	48	407.1
16" x 2"	16	1-1/8	42.5	7	1-1/8	42.5	2	6	6	5	52	456.1
16" x 2-1/8"	16	1-1/8	48.5	7	1-1/4	48.5	2	7	7	5	56	541.4
16" x 2-1/4"	16	1-1/4	54.5	7	1-1/4	48.5	2	8	7	5	60	606.8
17" x 3/4"	17	3/8	24.5	7.5	1/2	24.5	2.25	3	3	1	24	119.2
17" x 7/8"	17	1/2	24.5	7.5	1/2	24.5	2.25	3	3	1	24	134.0
17" x 1"	17	1/2	24.5	7.5	5/8	24.5	2.25	3	3	2	28	150.8
17" x 1-1/8"	17	5/8	30.5	7.5	5/8	30.5	2.25	4	4	2	32	203.4
17" x 1-1/4"	17	5/8	36.5	7.5	3/4	30.5	2.25	5	4	2	36	241.5
17" x 1-3/8"	17	3/4	36.5	7.5	3/4	36.5	2.25	5	5	3	40	286.4
17" x 1-1/2"	17	3/4	42.5	7.5	7/8	36.5	2.25	6	5	3	44	331.3
17" x 1-5/8"	17	7/8	42.5	7.5	7/8	42.5	2.25	6	6	4	48	383.0
17" x 1-3/4"	17	7/8	42.5	7.5	1	42.5	2.25	6	6	4	48	405.6
17" x 1-7/8"	17	1	42.5	7.5	1	42.5	2.25	6	6	5	52	435.0
17" x 2"	17	1-1/8	48.5	7.5	1-1/8	48.5	2.25	7	7	5	56	548.3
17" x 2-1/8"	17	1-1/8	54.5	7.5	1-1/8	48.5	2.25	8	7	5	60	584.6
17" x 2-1/4"	17	1-1/4	54.5	7.5	1-1/4	54.5	2.25	8	8	6	64	679.0
18" x 3/4"	18	3/8	24.5	8	1/2	24.5	2.5	3	3	1	24	125.3
18" x 7/8"	18	1/2	30.5	8	1/2	24.5	2.5	4	3	1	28	160.0
18" x 1"	18	1/2	30.5	8	5/8	30.5	2.5	4	4	2	32	194.7
18" x 1-1/8"	18	5/8	36.5	8	5/8	30.5	2.5	5	4	2	36	237.1
18" x 1-1/4"	18	5/8	36.5	8	3/4	36.5	2.5	5	5	3	40	278.6
18" x 1-3/8"	18	3/4	42.5	8	3/4	36.5	2.5	6	5	3	44	328.7
18" x 1-1/2"	18	3/4	36.5	8	7/8	36.5	2.5	5	5	4	44	326.4
18" x 1-5/8"	18	7/8	42.5	8	7/8	42.5	2.5	6	6	4	48	404.1
18" x 1-3/4"	18	7/8	42.5	8	1	42.5	2.5	6	6	5	52	432.0
18" x 1-7/8"	18	1	48.5	8	1	48.5	2.5	7	7	5	56	520.8
18" x 2"	18	1	48.5	8	1-1/8	48.5	2.5	7	7	6	60	552.1
18" x 2-1/8"	18	1-1/8	54.5	8	1-1/8	54.5	2.5	8	8	6	64	651.9
18" x 2-1/4"	18	1-1/4	60.5	8	1-1/4	54.5	2.5	9	8	6	68	759.7

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 36 Flanges, Grade 36 Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
19" x 3/4"	19	3/8	24.5	8.5	1/2	24.5	2.75	3	3	1	24	131.4
19" x 7/8"	19	1/2	24.5	8.5	1/2	24.5	2.75	3	3	2	28	151.7
19" x 1"	19	1/2	30.5	8.5	5/8	30.5	2.75	4	4	2	32	204.5
19" x 1-1/8"	19	5/8	30.5	8.5	5/8	30.5	2.75	4	4	3	36	228.8
19" x 1-1/4"	19	5/8	36.5	8.5	3/4	36.5	2.75	5	5	3	40	292.9
19" x 1-3/8"	19	3/4	36.5	8.5	3/4	36.5	2.75	5	5	4	44	321.3
19" x 1-1/2"	19	3/4	42.5	8.5	7/8	42.5	2.75	6	6	4	48	396.6
19" x 1-5/8"	19	7/8	42.5	8.5	7/8	42.5	2.75	6	6	5	52	429.0
19" x 1-3/4"	19	7/8	48.5	8.5	1	48.5	2.75	7	7	5	56	515.6
19" x 1-7/8"	19	1	48.5	8.5	1	48.5	2.75	7	7	6	60	552.1
19" x 2"	19	1	54.5	8.5	1-1/8	54.5	2.75	8	8	6	64	650.0
19" x 2-1/8"	19	1-1/8	60.5	8.5	1-1/8	60.5	2.75	9	8	6	68	726.9
19" x 2-1/4"	19	1-1/8	60.5	8.5	1-1/4	60.5	2.75	9	9	7	72	799.7
20" x 3/4"	20	3/8	30.5	9	1/2	24.5	3	4	3	1	28	154.0
20" x 7/8"	20	1/2	30.5	9	1/2	30.5	3	4	4	2	32	194.7
20" x 1"	20	1/2	36.5	9	5/8	30.5	3	5	4	2	36	235.0
20" x 1-1/8"	20	5/8	36.5	9	5/8	36.5	3	5	5	3	40	283.8
20" x 1-1/4"	20	5/8	42.5	9	3/4	36.5	3	6	5	3	44	332.2
20" x 1-3/8"	20	3/4	42.5	9	3/4	42.5	3	6	6	4	48	389.1
20" x 1-1/2"	20	3/4	48.5	9	7/8	42.5	3	7	6	4	52	445.5
20" x 1-5/8"	20	7/8	48.5	9	7/8	48.5	3	7	7	5	56	510.5
20" x 1-3/4"	20	7/8	54.5	9	1	48.5	3	8	7	5	60	575.0
20" x 1-7/8"	20	1	54.5	9	1	54.5	3	8	8	6	64	648.1
20" x 2"	20	1	54.5	9	1-1/8	54.5	3	8	8	7	68	686.6
20" x 2-1/8"	20	1-1/8	60.5	9	1-1/8	60.5	3	9	9	7	72	801.8
20" x 2-1/4"	20	1-1/8	60.5	9	1-1/4	60.5	3	9	9	8	76	844.2
21" x 3/4"	21	3/8	24.5	9.5	1/2	24.5	3.25	3	3	2	28	147.3
21" x 7/8"	21	1/2	30.5	9.5	1/2	30.5	3.25	4	4	2	32	203.4
21" x 1"	21	1/2	30.5	9.5	5/8	30.5	3.25	4	4	3	36	227.7
21" x 1-1/8"	21	5/8	36.5	9.5	5/8	36.5	3.25	5	5	3	40	296.8
21" x 1-1/4"	21	5/8	36.5	9.5	3/4	36.5	3.25	5	5	4	44	325.1
21" x 1-3/8"	21	3/4	48.5	9.5	3/4	42.5	3.25	7	6	4	52	437.7
21" x 1-1/2"	21	3/4	48.5	9.5	7/8	48.5	3.25	7	7	5	56	498.4
21" x 1-5/8"	21	7/8	54.5	9.5	7/8	48.5	3.25	8	7	5	60	569.6
21" x 1-3/4"	21	7/8	54.5	9.5	1	54.5	3.25	8	8	6	64	638.4
21" x 1-7/8"	21	1	60.5	9.5	1	54.5	3.25	9	8	6	68	718.5
21" x 2"	21	1	60.5	9.5	1-1/8	60.5	3.25	9	9	7	72	795.4
21" x 2-1/8"	21	1-1/8	60.5	9.5	1-1/8	60.5	3.25	9	9	8	76	844.2
21" x 2-1/4"	21	1-1/8	66.5	9.5	1-1/4	66.5	3.25	10	10	8	80	969.4

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 36 Flanges, Grade 36 Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
22" x 3/4"	22	3/8	24.5	10	1/2	24.5	3.5	3	3	2	28	153.4
22" x 7/8"	22	1/2	36.5	10	1/2	30.5	3.5	5	4	2	36	234.5
22" x 1"	22	1/2	36.5	10	5/8	36.5	3.5	5	5	3	40	281.2
22" x 1-1/8"	22	5/8	42.5	10	5/8	36.5	3.5	6	5	3	44	336.9
22" x 1-1/4"	22	5/8	42.5	10	3/4	42.5	3.5	6	6	4	48	392.1
22" x 1-3/8"	22	3/4	42.5	10	3/4	42.5	3.5	6	6	5	52	429.0
22" x 1-1/2"	22	3/4	48.5	10	7/8	48.5	3.5	7	7	5	56	520.8
22" x 1-5/8"	22	7/8	54.5	10	7/8	54.5	3.5	8	8	6	64	628.7
22" x 1-3/4"	22	7/8	60.5	10	1	54.5	3.5	9	8	6	68	703.9
22" x 1-7/8"	22	1	60.5	10	1	60.5	3.5	9	9	7	72	788.9
22" x 2"	22	1	60.5	10	1-1/8	60.5	3.5	9	9	8	76	835.6
22" x 2-1/8"	22	1-1/8	66.5	10	1-1/8	66.5	3.5	10	10	8	80	967.0
22" x 2-1/4"	22	1-1/8	66.5	10	1-1/4	66.5	3.5	10	10	9	84	1017.9
23" x 3/4"	23	3/8	30.5	10.5	1/2	30.5	3.75	4	4	2	32	195.8
23" x 7/8"	23	1/2	30.5	10.5	1/2	30.5	3.75	4	4	3	36	224.5
23" x 1"	23	1/2	36.5	10.5	5/8	36.5	3.75	5	5	3	40	292.9
23" x 1-1/8"	23	5/8	42.5	10.5	5/8	42.5	3.75	6	6	4	48	377.0
23" x 1-1/4"	23	5/8	48.5	10.5	3/4	42.5	3.75	7	6	4	52	436.9
23" x 1-3/8"	23	3/4	48.5	10.5	3/4	48.5	3.75	7	7	5	56	507.0
23" x 1-1/2"	23	3/4	48.5	10.5	7/8	48.5	3.75	7	7	6	60	546.9
23" x 1-5/8"	23	7/8	54.5	10.5	7/8	54.5	3.75	8	8	6	64	655.8
23" x 1-3/4"	23	7/8	60.5	10.5	1	60.5	3.75	9	9	7	72	773.9
23" x 1-7/8"	23	1	66.5	10.5	1	60.5	3.75	10	9	7	76	866.2
23" x 2"	23	1	66.5	10.5	1-1/8	66.5	3.75	10	10	8	80	955.2
23" x 2-1/8"	23	1-1/8	66.5	10.5	1-1/8	66.5	3.75	10	10	9	84	1013.2
23" x 2-1/4"	23	1-1/8	78.5	10.5	1-1/4	72.5	3.75	12	11	9	92	1203.0
24" x 3/4"	24	3/8	30.5	11	1/2	30.5	4	4	4	2	32	203.4
24" x 7/8"	24	1/2	36.5	11	1/2	36.5	4	5	5	3	40	276.1
24" x 1"	24	1/2	42.5	11	5/8	36.5	4	6	5	3	44	328.7
24" x 1-1/8"	24	5/8	42.5	11	5/8	42.5	4	6	6	4	48	392.1
24" x 1-1/4"	24	5/8	42.5	11	3/4	42.5	4	6	6	5	52	429.0
24" x 1-3/8"	24	3/4	54.5	11	3/4	48.5	4	8	7	5	60	562.1
24" x 1-1/2"	24	3/4	54.5	11	7/8	54.5	4	8	8	6	64	636.5
24" x 1-5/8"	24	7/8	54.5	11	7/8	54.5	4	8	8	7	68	686.6
24" x 1-3/4"	24	7/8	66.5	11	1	60.5	4	10	9	7	76	845.6
24" x 1-7/8"	24	1	66.5	11	1	66.5	4	10	10	8	80	943.4
24" x 2"	24	1	66.5	11	1-1/8	66.5	4	10	10	9	84	999.1
24" x 2-1/8"	24	1-1/8	72.5	11	1-1/8	72.5	4	11	11	9	88	1147.5
24" x 2-1/4"	24	1-1/8	78.5	11	1-1/4	78.5	4	12	12	10	96	1304.4

Bridge Manual

Welded Plate Girders – Section 3.42

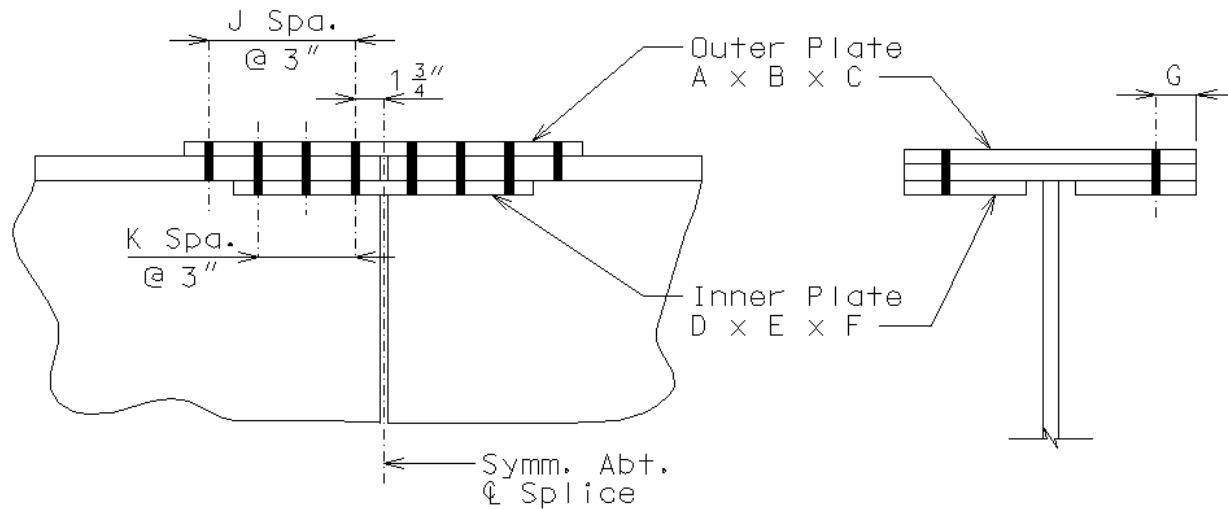
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Field Flange Splice – Bolted

Details

FLANGE PLATE SIZE: 12" THRU 13" (2 ROWS OF BOLTS)

ASTM A709, Grade 50 Flanges, Grade 36 Splice



Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
12" x 3/4"	12	5/8	36.5	5	5/8	30.5	2.5	5	4	0	24	154.5
12" x 7/8"	12	5/8	42.5	5	3/4	36.5	2.5	6	5	0	28	194.6
12" x 1"	12	3/4	48.5	5	3/4	42.5	2.5	7	6	0	32	244.6
12" x 1-1/8"	12	7/8	54.5	5	7/8	48.5	2.5	8	7	0	36	316.8
12" x 1-1/4"	12	1	54.5	5	1	54.5	2.5	8	8	0	36	374.2
12" x 1-3/8"	12	1	60.5	5	1-1/8	60.5	2.5	9	9	0	40	436.9
12" x 1-1/2"	12	1-1/8	66.5	5	1-1/8	66.5	2.5	10	10	0	44	508.5
12" x 1-5/8"	12	1-1/4	72.5	5	1-1/4	72.5	2.5	11	11	0	48	611.0
12" x 1-3/4"	12	1-3/8	78.5	5	1-3/8	72.5	2.5	12	11	0	52	699.4
12" x 1-7/8"	12	1-3/8	84.5	5	1-1/2	78.5	2.5	13	12	0	56	782.5
12" x 2"	12	1-1/2	90.5	5	1-1/2	84.5	2.5	14	13	0	60	878.3
12" x 2-1/8"	12	1-5/8	96.5	5	1-5/8	90.5	2.5	15	14	0	64	1011.4
12" x 2-1/4"	12	1-3/4	102.5	5	1-3/4	96.5	2.5	16	15	0	68	1153.8
13" x 3/4"	13	5/8	36.5	5.5	5/8	36.5	2.75	5	5	0	24	178.1
13" x 7/8"	13	5/8	42.5	5.5	3/4	42.5	2.75	6	6	0	28	223.9
13" x 1"	13	3/4	48.5	5.5	3/4	48.5	2.75	7	7	0	32	278.0
13" x 1-1/8"	13	7/8	54.5	5.5	7/8	54.5	2.75	8	8	0	36	358.7
13" x 1-1/4"	13	7/8	60.5	5.5	1	60.5	2.75	9	9	0	40	421.9
13" x 1-3/8"	13	1	66.5	5.5	1-1/8	66.5	2.75	10	10	0	44	520.3
13" x 1-1/2"	13	1-1/8	72.5	5.5	1-1/8	72.5	2.75	11	11	0	48	600.7
13" x 1-5/8"	13	1-1/4	78.5	5.5	1-1/4	78.5	2.75	12	12	0	52	717.2
13" x 1-3/4"	13	1-1/4	84.5	5.5	1-3/8	84.5	2.75	13	13	0	56	805.0
13" x 1-7/8"	13	1-3/8	90.5	5.5	1-1/2	90.5	2.75	14	14	0	60	939.2
13" x 2"	13	1-1/2	96.5	5.5	1-1/2	96.5	2.75	15	15	0	64	1045.9
13" x 2-1/8"	13	1-5/8	102.5	5.5	1-5/8	102.5	2.75	16	16	0	68	1198.2
13" x 2-1/4"	13	1-5/8	108.5	5.5	1-3/4	108.5	2.75	17	17	0	72	1310.6

Bridge Manual

Welded Plate Girders – Section 3.42

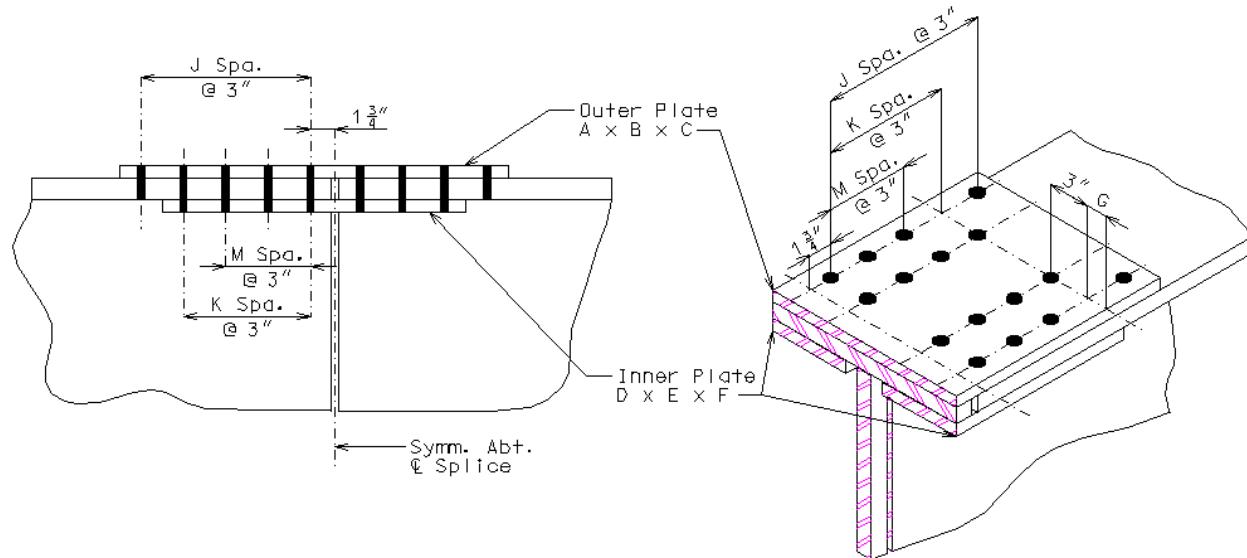
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Field Flange Splice – Bolted

Details

FLANGE PLATE SIZE: 14" THRU 15" (4 ROWS OF BOLTS)

ASTM A709, Grade 50 Flanges, Grade 36 Splice



This table is not appropriate if P/S panel option is used because the edge distance "G" shall be equal to or greater than 2". See Section 3.40 page 3.3-2 for detail.

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
14" x 3/4"	14	5/8	24.5	6	5/8	24.5	1.5	3	3	1	24	135.7
14" x 7/8"	14	5/8	30.5	6	3/4	24.5	1.5	4	3	1	28	164.8
14" x 1"	14	3/4	30.5	6	3/4	30.5	1.5	4	4	2	32	199.1
14" x 1-1/8"	14	7/8	36.5	6	7/8	30.5	1.5	5	4	2	36	251.8
14" x 1-1/4"	14	1	30.5	6	1	30.5	1.5	4	4	3	36	259.1
14" x 1-3/8"	14	1	36.5	6	1-1/8	36.5	1.5	5	5	3	40	322.6
14" x 1-1/2"	14	1-1/8	36.5	6	1-1/8	36.5	1.5	5	5	4	44	344.5
14" x 1-5/8"	14	1-1/4	42.5	6	1-1/4	42.5	1.5	6	6	4	48	437.3
14" x 1-3/4"	14	1-3/8	48.5	6	1-3/8	42.5	1.5	7	6	4	52	513.0
14" x 1-7/8"	14	1-3/8	48.5	6	1-1/2	48.5	1.5	7	7	5	56	565.5
14" x 2"	14	1-1/2	54.5	6	1-1/2	48.5	1.5	8	7	5	60	629.1
14" x 2-1/8"	14	1-5/8	54.5	6	1-5/8	54.5	1.5	8	8	6	64	713.7
14" x 2-1/4"	14	1-3/4	60.5	6	1-3/4	54.5	1.5	9	8	6	68	809.5
<hr/>												
15" x 3/4"	15	1/2	24.5	6.5	5/8	24.5	1.75	3	3	1	24	131.4
15" x 7/8"	15	5/8	24.5	6.5	3/4	24.5	1.75	3	3	2	28	159.5
15" x 1"	15	3/4	30.5	6.5	3/4	30.5	1.75	4	4	2	32	212.0
15" x 1-1/8"	15	7/8	30.5	6.5	7/8	30.5	1.75	4	4	3	36	246.1
15" x 1-1/4"	15	7/8	36.5	6.5	1	36.5	1.75	5	5	3	40	308.4
15" x 1-3/8"	15	1	36.5	6.5	1-1/8	36.5	1.75	5	5	4	44	348.4
15" x 1-1/2"	15	1-1/8	42.5	6.5	1-1/8	42.5	1.75	6	6	4	48	425.2
15" x 1-5/8"	15	1-1/4	42.5	6.5	1-1/4	42.5	1.75	6	6	5	52	471.2
15" x 1-3/4"	15	1-1/4	48.5	6.5	1-3/8	48.5	1.75	7	7	5	56	556.9
15" x 1-7/8"	15	1-3/8	48.5	6.5	1-1/2	48.5	1.75	7	7	6	60	608.8
15" x 2"	15	1-1/2	54.5	6.5	1-1/2	54.5	1.75	8	8	6	64	709.9
15" x 2-1/8"	15	1-5/8	54.5	6.5	1-5/8	54.5	1.75	8	8	7	68	767.8
15" x 2-1/4"	15	1-5/8	60.5	6.5	1-3/4	60.5	1.75	9	9	7	72	876.9

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 50 Flanges, Grade 36 Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
16" x 3/4"	16	1/2	30.5	7	5/8	24.5	2	4	3	1	28	156.6
16" x 7/8"	16	5/8	30.5	7	3/4	30.5	2	4	4	2	32	207.7
16" x 1"	16	3/4	30.5	7	3/4	30.5	2	4	4	3	36	228.8
16" x 1-1/8"	16	7/8	36.5	7	7/8	36.5	2	5	5	3	40	309.7
16" x 1-1/4"	16	7/8	36.5	7	1	36.5	2	5	5	4	44	331.6
16" x 1-3/8"	16	1	42.5	7	1-1/8	42.5	2	6	6	4	48	428.2
16" x 1-1/2"	16	1-1/8	42.5	7	1-1/8	42.5	2	6	6	5	52	456.1
16" x 1-5/8"	16	1-1/4	48.5	7	1-1/4	48.5	2	7	7	5	56	568.9
16" x 1-3/4"	16	1-1/4	54.5	7	1-3/8	54.5	2	8	8	6	64	667.4
16" x 1-7/8"	16	1-3/8	60.5	7	1-1/2	54.5	2	9	8	6	68	766.6
16" x 2"	16	1-1/2	60.5	7	1-1/2	60.5	2	9	9	7	72	840.4
16" x 2-1/8"	16	1-5/8	66.5	7	1-5/8	60.5	2	10	9	7	76	952.8
16" x 2-1/4"	16	1-5/8	66.5	7	1-3/4	66.5	2	10	10	8	80	1028.3
17" x 3/4"	17	1/2	24.5	7.5	5/8	24.5	2.25	3	3	2	28	150.8
17" x 7/8"	17	5/8	36.5	7.5	3/4	30.5	2.25	5	4	2	36	241.5
17" x 1"	17	3/4	36.5	7.5	3/4	36.5	2.25	5	5	3	40	286.4
17" x 1-1/8"	17	7/8	42.5	7.5	7/8	36.5	2.25	6	5	3	44	356.9
17" x 1-1/4"	17	7/8	42.5	7.5	1	42.5	2.25	6	6	4	48	405.6
17" x 1-3/8"	17	1	42.5	7.5	1-1/8	42.5	2.25	6	6	5	52	457.6
17" x 1-1/2"	17	1-1/8	48.5	7.5	1-1/8	48.5	2.25	7	7	5	56	548.3
17" x 1-5/8"	17	1-1/4	54.5	7.5	1-1/4	54.5	2.25	8	8	6	64	679.0
17" x 1-3/4"	17	1-1/4	60.5	7.5	1-3/8	54.5	2.25	9	8	6	68	747.9
17" x 1-7/8"	17	1-3/8	60.5	7.5	1-3/8	60.5	2.25	9	9	7	72	823.2
17" x 2"	17	1-1/2	60.5	7.5	1-1/2	60.5	2.25	9	9	8	76	895.7
17" x 2-1/8"	17	1-1/2	66.5	7.5	1-5/8	66.5	2.25	10	10	8	80	1016.5
17" x 2-1/4"	17	1-5/8	66.5	7.5	1-3/4	66.5	2.25	10	10	9	84	1095.7
18" x 3/4"	18	1/2	30.5	8	5/8	30.5	2.5	4	4	2	32	194.7
18" x 7/8"	18	5/8	30.5	8	3/4	30.5	2.5	4	4	3	36	235.3
18" x 1"	18	3/4	42.5	8	3/4	36.5	2.5	6	5	3	44	328.7
18" x 1-1/8"	18	7/8	42.5	8	7/8	42.5	2.5	6	6	4	48	404.1
18" x 1-1/4"	18	7/8	48.5	8	1	42.5	2.5	7	6	4	52	458.8
18" x 1-3/8"	18	1	48.5	8	1	48.5	2.5	7	7	5	56	520.8
18" x 1-1/2"	18	1-1/8	54.5	8	1-1/8	54.5	2.5	8	8	6	64	651.9
18" x 1-5/8"	18	1-1/8	60.5	8	1-1/4	54.5	2.5	9	8	6	68	721.1
18" x 1-3/4"	18	1-1/4	60.5	8	1-3/8	60.5	2.5	9	9	7	72	831.8
18" x 1-7/8"	18	1-3/8	60.5	8	1-3/8	60.5	2.5	9	9	8	76	874.2
18" x 2"	18	1-1/2	72.5	8	1-1/2	66.5	2.5	11	10	8	84	1087.4
18" x 2-1/8"	18	1-1/2	72.5	8	1-5/8	72.5	2.5	11	11	9	88	1173.2
18" x 2-1/4"	18	1-5/8	78.5	8	1-3/4	72.5	2.5	12	11	9	92	1314.1

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 50 Flanges, Grade 36 Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
19" x 3/4"	19	1/2	36.5	8.5	5/8	30.5	2.75	5	4	2	36	224.4
19" x 7/8"	19	5/8	36.5	8.5	3/4	36.5	2.75	5	5	3	40	292.9
19" x 1"	19	3/4	36.5	8.5	3/4	36.5	2.75	5	5	4	44	321.3
19" x 1-1/8"	19	7/8	48.5	8.5	7/8	42.5	2.75	7	6	4	52	457.3
19" x 1-1/4"	19	7/8	48.5	8.5	1	48.5	2.75	7	7	5	56	515.6
19" x 1-3/8"	19	1	48.5	8.5	1	48.5	2.75	7	7	6	60	552.1
19" x 1-1/2"	19	1-1/8	60.5	8.5	1-1/8	54.5	2.75	9	8	6	68	726.9
19" x 1-5/8"	19	1-1/8	60.5	8.5	1-1/4	60.5	2.75	9	9	7	72	799.7
19" x 1-3/4"	19	1-1/4	60.5	8.5	1-3/8	60.5	2.75	9	9	8	76	880.7
19" x 1-7/8"	19	1-3/8	72.5	8.5	1-3/8	66.5	2.75	11	10	8	84	1057.7
19" x 2"	19	1-1/2	72.5	8.5	1-1/2	72.5	2.75	11	11	9	88	1193.8
19" x 2-1/8"	19	1-1/2	72.5	8.5	1-5/8	72.5	2.75	11	11	10	92	1241.2
19" x 2-1/4"	19	1-5/8	84.5	8.5	1-3/4	78.5	2.75	13	12	10	100	1497.0
20" x 3/4"	20	1/2	30.5	9	5/8	30.5	3	4	4	3	36	218.0
20" x 7/8"	20	5/8	36.5	9	3/4	36.5	3	5	5	3	40	307.1
20" x 1"	20	3/4	42.5	9	3/4	42.5	3	6	6	4	48	389.1
20" x 1-1/8"	20	7/8	42.5	9	7/8	42.5	3	6	6	5	52	450.1
20" x 1-1/4"	20	7/8	54.5	9	1	48.5	3	8	7	5	60	575.0
20" x 1-3/8"	20	1	54.5	9	1	54.5	3	8	8	6	64	648.1
20" x 1-1/2"	20	1-1/8	60.5	9	1-1/8	60.5	3	9	9	7	72	801.8
20" x 1-5/8"	20	1-1/8	60.5	9	1-1/4	60.5	3	9	9	8	76	844.2
20" x 1-3/4"	20	1-1/4	66.5	9	1-3/8	66.5	3	10	10	8	80	1014.1
20" x 1-7/8"	20	1-3/8	72.5	9	1-3/8	72.5	3	11	11	9	88	1157.8
20" x 2"	20	1-1/2	72.5	9	1-1/2	72.5	3	11	11	10	92	1259.2
20" x 2-1/8"	20	1-1/2	84.5	9	1-5/8	78.5	3	13	12	10	100	1464.9
20" x 2-1/4"	20	1-5/8	84.5	9	1-5/8	84.5	3	13	13	11	104	1578.4
21" x 3/4"	21	1/2	36.5	9.5	5/8	36.5	3.25	5	5	3	40	269.6
21" x 7/8"	21	5/8	36.5	9.5	3/4	36.5	3.25	5	5	4	44	325.1
21" x 1"	21	3/4	48.5	9.5	3/4	42.5	3.25	7	6	4	52	437.7
21" x 1-1/8"	21	3/4	48.5	9.5	7/8	48.5	3.25	7	7	5	56	498.4
21" x 1-1/4"	21	7/8	54.5	9.5	1	54.5	3.25	8	8	6	64	638.4
21" x 1-3/8"	21	1	54.5	9.5	1	54.5	3.25	8	8	7	68	682.8
21" x 1-1/2"	21	1-1/8	66.5	9.5	1-1/8	60.5	3.25	10	9	7	76	884.4
21" x 1-5/8"	21	1-1/8	66.5	9.5	1-1/4	66.5	3.25	10	10	8	80	969.4
21" x 1-3/4"	21	1-1/4	72.5	9.5	1-3/8	72.5	3.25	11	11	9	88	1160.3
21" x 1-7/8"	21	1-3/8	72.5	9.5	1-3/8	72.5	3.25	11	11	10	92	1218.1
21" x 2"	21	1-1/2	84.5	9.5	1-1/2	78.5	3.25	13	12	10	100	1484.2
21" x 2-1/8"	21	1-1/2	84.5	9.5	1-5/8	84.5	3.25	13	13	11	104	1593.4
21" x 2-1/4"	21	1-5/8	90.5	9.5	1-5/8	90.5	3.25	14	14	12	112	1774.5

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 50 Flanges, Grade 36 Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
22" x 3/4"	22	1/2	36.5	10	5/8	36.5	3.5	5	5	3	40	281.2
22" x 7/8"	22	5/8	42.5	10	3/4	42.5	3.5	6	6	4	48	392.1
22" x 1"	22	3/4	42.5	10	3/4	42.5	3.5	6	6	5	52	429.0
22" x 1-1/8"	22	3/4	54.5	10	7/8	48.5	3.5	8	7	5	60	552.7
22" x 1-1/4"	22	7/8	60.5	10	1	54.5	3.5	9	8	6	68	703.9
22" x 1-3/8"	22	1	60.5	10	1	60.5	3.5	9	9	7	72	788.9
22" x 1-1/2"	22	1-1/8	66.5	10	1-1/8	66.5	3.5	10	10	8	80	967.0
22" x 1-5/8"	22	1-1/8	66.5	10	1-1/4	66.5	3.5	10	10	9	84	1017.9
22" x 1-3/4"	22	1-1/4	78.5	10	1-3/8	72.5	3.5	12	11	9	92	1264.9
22" x 1-7/8"	22	1-3/8	84.5	10	1-3/8	78.5	3.5	13	12	10	100	1432.0
22" x 2"	22	1-3/8	84.5	10	1-1/2	84.5	3.5	13	13	11	104	1542.5
22" x 2-1/8"	22	1-1/2	90.5	10	1-5/8	90.5	3.5	14	14	12	112	1787.3
22" x 2-1/4"	22	1-5/8	90.5	10	1-5/8	90.5	3.5	14	14	13	116	1861.7
23" x 3/4"	23	1/2	42.5	10.5	5/8	36.5	3.75	6	5	3	44	316.2
23" x 7/8"	23	5/8	42.5	10.5	5/8	42.5	3.75	6	6	4	48	377.0
23" x 1"	23	3/4	48.5	10.5	3/4	48.5	3.75	7	7	5	56	507.0
23" x 1-1/8"	23	3/4	54.5	10.5	7/8	54.5	3.75	8	8	6	64	611.4
23" x 1-1/4"	23	7/8	54.5	10.5	1	54.5	3.75	8	8	7	68	700.2
23" x 1-3/8"	23	1	60.5	10.5	1	60.5	3.75	9	9	8	76	827.0
23" x 1-1/2"	23	1-1/8	72.5	10.5	1-1/8	66.5	3.75	11	10	8	84	1057.2
23" x 1-5/8"	23	1-1/8	78.5	10.5	1-1/4	72.5	3.75	12	11	9	92	1203.0
23" x 1-3/4"	23	1-1/4	78.5	10.5	1-1/4	78.5	3.75	12	12	10	96	1315.5
23" x 1-7/8"	23	1-3/8	84.5	10.5	1-3/8	84.5	3.75	13	13	11	104	1548.5
23" x 2"	23	1-3/8	90.5	10.5	1-1/2	90.5	3.75	14	14	12	112	1726.4
23" x 2-1/8"	23	1-1/2	90.5	10.5	1-5/8	90.5	3.75	14	14	13	116	1871.3
23" x 2-1/4"	23	1-5/8	102.5	10.5	1-5/8	96.5	3.75	16	15	13	124	2137.9
24" x 3/4"	24	1/2	36.5	11	5/8	36.5	4	5	5	4	44	308.3
24" x 7/8"	24	5/8	48.5	11	5/8	42.5	4	7	6	4	52	421.4
24" x 1"	24	3/4	54.5	11	3/4	48.5	4	8	7	5	60	562.1
24" x 1-1/8"	24	3/4	60.5	11	7/8	54.5	4	9	8	6	68	670.9
24" x 1-1/4"	24	7/8	60.5	11	1	60.5	4	9	9	7	72	806.1
24" x 1-3/8"	24	1	66.5	11	1	66.5	4	10	10	8	80	943.4
24" x 1-1/2"	24	1-1/8	72.5	11	1-1/8	72.5	4	11	11	9	88	1147.5
24" x 1-5/8"	24	1-1/8	78.5	11	1-1/4	78.5	4	12	12	10	96	1304.4
24" x 1-3/4"	24	1-1/4	78.5	11	1-1/4	78.5	4	12	12	11	100	1374.9
24" x 1-7/8"	24	1-3/8	84.5	11	1-3/8	84.5	4	13	13	12	108	1618.1
24" x 2"	24	1-3/8	96.5	11	1-1/2	90.5	4	15	14	12	116	1860.1
24" x 2-1/8"	24	1-1/2	102.5	11	1-5/8	96.5	4	16	15	13	124	2142.4
24" x 2-1/4"	24	1-5/8	108.5	11	1-5/8	102.5	4	17	16	14	132	2364.4

Bridge Manual

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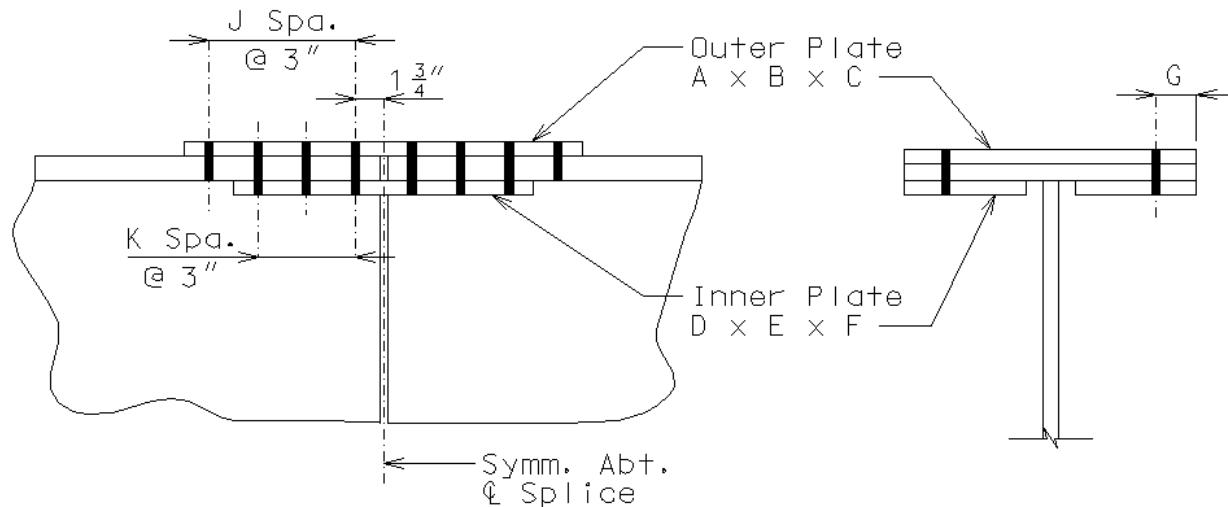
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Field Flange Splice – Bolted

Details

FLANGE PLATE SIZE: 12" THRU 13" (2 ROWS OF BOLTS)

ASTM A709, Grade 50W Flanges, Grade 50W Splice



Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
12" x 3/4"	12	3/8	36.5	5	1/2	30.5	2.5	5	4	0	24	112.6
12" x 7/8"	12	1/2	42.5	5	1/2	36.5	2.5	6	5	0	28	150.7
12" x 1"	12	1/2	48.5	5	5/8	42.5	2.5	7	6	0	32	188.2
12" x 1-1/8"	12	5/8	54.5	5	5/8	48.5	2.5	8	7	0	36	236.1
12" x 1-1/4"	12	5/8	54.5	5	3/4	54.5	2.5	8	8	0	36	266.0
12" x 1-3/8"	12	3/4	60.5	5	3/4	60.5	2.5	9	9	0	40	321.1
12" x 1-1/2"	12	7/8	66.5	5	7/8	66.5	2.5	10	10	0	44	404.8
12" x 1-5/8"	12	7/8	72.5	5	1	72.5	2.5	11	11	0	48	467.0
12" x 1-3/4"	12	1	78.5	5	1	72.5	2.5	12	11	0	52	522.1
12" x 1-7/8"	12	1	84.5	5	1-1/8	78.5	2.5	13	12	0	56	591.2
12" x 2"	12	1-1/8	90.5	5	1-1/8	84.5	2.5	14	13	0	60	673.0
12" x 2-1/8"	12	1-1/8	96.5	5	1-1/4	90.5	2.5	15	14	0	64	751.0
12" x 2-1/4"	12	1-1/4	102.5	5	1-1/4	96.5	2.5	16	15	0	68	842.6
13" x 3/4"	13	3/8	36.5	5.5	1/2	36.5	2.75	5	5	0	24	130.2
13" x 7/8"	13	1/2	42.5	5.5	1/2	42.5	2.75	6	6	0	28	171.2
13" x 1"	13	1/2	48.5	5.5	5/8	48.5	2.75	7	7	0	32	214.3
13" x 1-1/8"	13	5/8	72.5	5.5	5/8	66.5	2.75	11	10	0	48	342.3
13" x 1-1/4"	13	5/8	60.5	5.5	3/4	60.5	2.75	9	9	0	40	318.9
13" x 1-3/8"	13	3/4	66.5	5.5	3/4	66.5	2.75	10	10	0	44	381.2
13" x 1-1/2"	13	7/8	72.5	5.5	7/8	72.5	2.75	11	11	0	48	477.3
13" x 1-5/8"	13	7/8	78.5	5.5	1	78.5	2.75	12	12	0	52	547.5
13" x 1-3/4"	13	1	84.5	5.5	1	84.5	2.75	13	13	0	56	628.3
13" x 1-7/8"	13	1	90.5	5.5	1-1/8	90.5	2.75	14	14	0	60	708.2
13" x 2"	13	1-1/8	96.5	5.5	1-1/8	96.5	2.75	15	15	0	64	799.6
13" x 2-1/8"	13	1-1/8	102.5	5.5	1-1/4	102.5	2.75	16	16	0	68	889.3
13" x 2-1/4"	13	1-1/4	108.5	5.5	1-1/4	108.5	2.75	17	17	0	72	991.4

Bridge Manual

Welded Plate Girders – Section 3.42

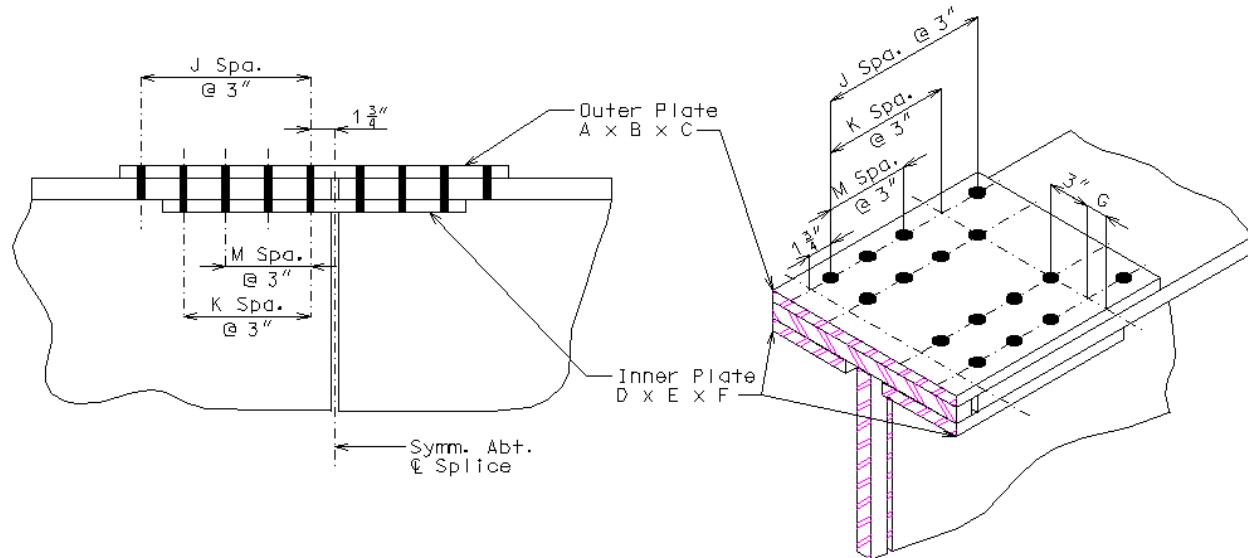
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Field Flange Splice – Bolted

Details

Flange Plate Size: 14" Thru 15" (4 Rows of Bolts)

ASTM A709, Grade 50W Flanges, Grade 50W Splice



This table is not appropriate if P/S panel option is used because the edge distance "G" shall be equal to or greater than 2". See Section 3.40 page 3.3-2 for detail.

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
14" x 3/4"	14	3/8	24.5	6	1/2	24.5	1.5	3	3	1	24	101.0
14" x 7/8"	14	1/2	30.5	6	1/2	24.5	1.5	4	3	1	28	128.8
14" x 1"	14	1/2	30.5	6	5/8	30.5	1.5	4	4	2	32	155.8
14" x 1-1/8"	14	5/8	36.5	6	5/8	30.5	1.5	5	4	2	36	189.6
14" x 1-1/4"	14	5/8	36.5	6	3/4	36.5	1.5	5	5	3	40	221.7
14" x 1-3/8"	14	3/4	36.5	6	3/4	36.5	1.5	5	5	3	40	239.8
14" x 1-1/2"	14	7/8	36.5	6	7/8	36.5	1.5	5	5	4	44	277.3
14" x 1-5/8"	14	7/8	42.5	6	1	42.5	1.5	6	6	4	48	337.8
14" x 1-3/4"	14	1	42.5	6	1	42.5	1.5	6	6	5	52	362.7
14" x 1-7/8"	14	1	48.5	6	1-1/8	48.5	1.5	7	7	5	56	431.4
14" x 2"	14	1-1/8	54.5	6	1-1/8	48.5	1.5	8	7	5	60	486.1
14" x 2-1/8"	14	1-1/8	54.5	6	1-1/4	54.5	1.5	8	8	6	64	536.0
14" x 2-1/4"	14	1-1/4	60.5	6	1-1/4	54.5	1.5	9	8	6	68	596.6
15" x 3/4"	15	3/8	24.5	6.5	1/2	24.5	1.75	3	3	1	24	107.0
15" x 7/8"	15	1/2	24.5	6.5	1/2	24.5	1.75	3	3	2	28	123.9
15" x 1"	15	1/2	30.5	6.5	5/8	30.5	1.75	4	4	2	32	165.5
15" x 1-1/8"	15	5/8	30.5	6.5	5/8	30.5	1.75	4	4	3	36	185.6
15" x 1-1/4"	15	5/8	36.5	6.5	3/4	36.5	1.75	5	5	3	40	235.9
15" x 1-3/8"	15	3/4	36.5	6.5	3/4	36.5	1.75	5	5	4	44	259.2
15" x 1-1/2"	15	3/4	42.5	6.5	7/8	42.5	1.75	6	6	4	48	318.3
15" x 1-5/8"	15	7/8	42.5	6.5	7/8	42.5	1.75	6	6	5	52	344.7
15" x 1-3/4"	15	1	48.5	6.5	1	48.5	1.75	7	7	5	56	438.3
15" x 1-7/8"	15	1	48.5	6.5	1-1/8	48.5	1.75	7	7	6	60	464.4
15" x 2"	15	1-1/8	54.5	6.5	1-1/8	54.5	1.75	8	8	6	64	547.6
15" x 2-1/8"	15	1-1/8	54.5	6.5	1-1/4	54.5	1.75	8	8	7	68	576.5
15" x 2-1/4"	15	1-1/4	60.5	6.5	1-1/4	60.5	1.75	9	9	7	72	668.8

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 50W Flanges, Grade 50W Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
16" x 3/4"	16	3/8	30.5	7	1/2	24.5	2	4	3	1	28	127.1
16" x 7/8"	16	1/2	30.5	7	1/2	30.5	2	4	4	2	32	160.1
16" x 1"	16	1/2	30.5	7	5/8	30.5	2	4	4	3	36	179.1
16" x 1-1/8"	16	5/8	36.5	7	5/8	36.5	2	5	5	3	40	232.1
16" x 1-1/4"	16	5/8	36.5	7	3/4	36.5	2	5	5	4	44	254.0
16" x 1-3/8"	16	3/4	42.5	7	3/4	42.5	2	6	6	4	48	316.8
16" x 1-1/2"	16	3/4	42.5	7	7/8	42.5	2	6	6	5	52	341.6
16" x 1-5/8"	16	7/8	54.5	7	7/8	48.5	2	8	7	5	60	441.8
16" x 1-3/4"	16	1	54.5	7	1	54.5	2	8	8	6	64	524.4
16" x 1-7/8"	16	1	60.5	7	1	54.5	2	9	8	6	68	555.5
16" x 2"	16	1-1/8	60.5	7	1-1/8	60.5	2	9	9	7	72	647.4
16" x 2-1/8"	16	1-1/8	66.5	7	1-1/4	60.5	2	10	9	7	76	711.9
16" x 2-1/4"	16	1-1/4	66.5	7	1-1/4	66.5	2	10	10	8	80	783.1
17" x 3/4"	17	3/8	24.5	7.5	1/2	24.5	2.25	3	3	2	28	123.0
17" x 7/8"	17	1/2	36.5	7.5	1/2	30.5	2.25	5	4	2	36	187.0
17" x 1"	17	1/2	36.5	7.5	5/8	36.5	2.25	5	5	3	40	223.0
17" x 1-1/8"	17	5/8	42.5	7.5	5/8	36.5	2.25	6	5	3	44	266.9
17" x 1-1/4"	17	5/8	42.5	7.5	3/4	42.5	2.25	6	6	4	48	309.2
17" x 1-3/8"	17	3/4	42.5	7.5	3/4	42.5	2.25	6	6	5	52	338.6
17" x 1-1/2"	17	3/4	48.5	7.5	7/8	48.5	2.25	7	7	5	56	409.1
17" x 1-5/8"	17	7/8	54.5	7.5	7/8	54.5	2.25	8	8	6	64	493.5
17" x 1-3/4"	17	7/8	60.5	7.5	1	54.5	2.25	9	8	6	68	551.6
17" x 1-7/8"	17	1	60.5	7.5	1	60.5	2.25	9	9	7	72	617.4
17" x 2"	17	1-1/8	60.5	7.5	1-1/8	60.5	2.25	9	9	8	76	689.8
17" x 2-1/8"	17	1-1/8	66.5	7.5	1-1/8	66.5	2.25	10	10	8	80	754.9
17" x 2-1/4"	17	1-1/4	66.5	7.5	1-1/4	66.5	2.25	10	10	9	84	834.1
18" x 3/4"	18	3/8	30.5	8	1/2	30.5	2.5	4	4	2	32	158.0
18" x 7/8"	18	1/2	30.5	8	1/2	30.5	2.5	4	4	3	36	181.2
18" x 1"	18	1/2	42.5	8	5/8	36.5	2.5	6	5	3	44	253.8
18" x 1-1/8"	18	5/8	42.5	8	5/8	42.5	2.5	6	6	4	48	301.7
18" x 1-1/4"	18	5/8	42.5	8	3/4	42.5	2.5	6	6	5	52	329.6
18" x 1-3/8"	18	3/4	48.5	8	3/4	48.5	2.5	7	7	5	56	403.9
18" x 1-1/2"	18	3/4	54.5	8	7/8	54.5	2.5	8	8	6	64	485.8
18" x 1-5/8"	18	7/8	60.5	8	7/8	54.5	2.5	9	8	6	68	551.2
18" x 1-3/4"	18	7/8	60.5	8	1	60.5	2.5	9	9	7	72	613.1
18" x 1-7/8"	18	1	60.5	8	1	60.5	2.5	9	9	8	76	655.5
18" x 2"	18	1	72.5	8	1-1/8	66.5	2.5	11	10	8	84	789.3
18" x 2-1/8"	18	1-1/8	72.5	8	1-1/8	72.5	2.5	11	11	9	88	870.0
18" x 2-1/4"	18	1-1/4	72.5	8	1-1/4	72.5	2.5	11	11	10	92	961.1

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 50W Flanges, Grade 50W Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
19" x 3/4"	19	3/8	36.5	8.5	1/2	30.5	2.75	5	4	2	36	181.5
19" x 7/8"	19	1/2	36.5	8.5	1/2	36.5	2.75	5	5	3	40	224.3
19" x 1"	19	1/2	36.5	8.5	5/8	36.5	2.75	5	5	4	44	250.1
19" x 1-1/8"	19	5/8	48.5	8.5	5/8	42.5	2.75	7	6	4	52	340.8
19" x 1-1/4"	19	5/8	48.5	8.5	3/4	48.5	2.75	7	7	5	56	391.9
19" x 1-3/8"	19	3/4	48.5	8.5	3/4	48.5	2.75	7	7	6	60	428.3
19" x 1-1/2"	19	3/4	60.5	8.5	7/8	54.5	2.75	9	8	6	68	539.0
19" x 1-5/8"	19	7/8	60.5	8.5	7/8	60.5	2.75	9	9	7	72	608.8
19" x 1-3/4"	19	7/8	60.5	8.5	1	60.5	2.75	9	9	8	76	649.1
19" x 1-7/8"	19	1	72.5	8.5	1	66.5	2.75	11	10	8	84	791.0
19" x 2"	19	1	72.5	8.5	1-1/8	72.5	2.75	11	11	9	88	867.4
19" x 2-1/8"	19	1-1/8	72.5	8.5	1-1/8	72.5	2.75	11	11	10	92	920.0
19" x 2-1/4"	19	1-1/8	84.5	8.5	1-1/4	78.5	2.75	13	12	10	100	1080.2
20" x 3/4"	20	3/8	30.5	9	1/2	30.5	3	4	4	3	36	176.9
20" x 7/8"	20	1/2	36.5	9	1/2	36.5	3	5	5	3	40	234.7
20" x 1"	20	1/2	42.5	9	5/8	42.5	3	6	6	4	48	301.7
20" x 1-1/8"	20	5/8	42.5	9	5/8	42.5	3	6	6	5	52	335.6
20" x 1-1/4"	20	5/8	54.5	9	3/4	48.5	3	8	7	5	60	435.8
20" x 1-3/8"	20	3/4	54.5	9	3/4	54.5	3	8	8	6	64	501.2
20" x 1-1/2"	20	3/4	60.5	9	7/8	60.5	3	9	9	7	72	595.9
20" x 1-5/8"	20	7/8	60.5	9	7/8	60.5	3	9	9	8	76	642.6
20" x 1-3/4"	20	7/8	66.5	9	1	66.5	3	10	10	8	80	745.4
20" x 1-7/8"	20	1	72.5	9	1	72.5	3	11	11	9	88	864.8
20" x 2"	20	1	72.5	9	1-1/8	72.5	3	11	11	10	92	914.9
20" x 2-1/8"	20	1-1/8	84.5	9	1-1/8	78.5	3	13	12	10	100	1084.9
20" x 2-1/4"	20	1-1/8	84.5	9	1-1/4	84.5	3	13	13	11	104	1177.1
21" x 3/4"	21	3/8	36.5	9.5	1/2	36.5	3.25	5	5	3	40	217.8
21" x 7/8"	21	1/2	36.5	9.5	1/2	36.5	3.25	5	5	4	44	248.8
21" x 1"	21	1/2	48.5	9.5	5/8	42.5	3.25	7	6	4	52	336.9
21" x 1-1/8"	21	5/8	48.5	9.5	5/8	48.5	3.25	7	7	5	56	397.0
21" x 1-1/4"	21	5/8	54.5	9.5	3/4	54.5	3.25	8	8	6	64	483.9
21" x 1-3/8"	21	3/4	54.5	9.5	3/4	54.5	3.25	8	8	7	68	528.2
21" x 1-1/2"	21	3/4	66.5	9.5	7/8	60.5	3.25	10	9	7	76	654.4
21" x 1-5/8"	21	7/8	66.5	9.5	7/8	66.5	3.25	10	10	8	80	736.0
21" x 1-3/4"	21	7/8	72.5	9.5	1	72.5	3.25	11	11	9	88	852.0
21" x 1-7/8"	21	1	72.5	9.5	1	72.5	3.25	11	11	10	92	909.7
21" x 2"	21	1	84.5	9.5	1-1/8	78.5	3.25	13	12	10	100	1074.0
21" x 2-1/8"	21	1-1/8	84.5	9.5	1-1/8	84.5	3.25	13	13	11	104	1177.1
21" x 2-1/4"	21	1-1/8	90.5	9.5	1-1/4	90.5	3.25	14	14	12	112	1322.2

Bridge Manual

Welded Plate Girders – Section 3.42

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Field Flange Splice – Bolted

Details

Field Flange Splice (Cont.)

ASTM A709, Grade 50W Flanges, Grade 50W Splice

Flange Dimensions	"A" (in)	"B" (in)	"C" (in)	"D" (in)	"E" (in)	"F" (in)	"G" (in)	"J"	"K"	"M"	Total Number of Bolts	Wt./Flg. With 7/8" Bolts (lb)
22" x 3/4"	22	3/8	36.5	10	1/2	36.5	3.5	5	5	3	40	226.9
22" x 7/8"	22	1/2	42.5	10	1/2	42.5	3.5	6	6	4	48	298.7
22" x 1"	22	1/2	42.5	10	5/8	42.5	3.5	6	6	5	52	332.6
22" x 1-1/8"	22	5/8	66.5	10	5/8	60.5	3.5	10	9	7	76	545.9
22" x 1-1/4"	22	5/8	60.5	10	3/4	54.5	3.5	9	8	6	68	532.3
22" x 1-3/8"	22	3/4	60.5	10	3/4	60.5	3.5	9	9	7	72	608.8
22" x 1-1/2"	22	3/4	66.5	10	7/8	66.5	3.5	10	10	8	80	717.1
22" x 1-5/8"	22	7/8	66.5	10	7/8	66.5	3.5	10	10	9	84	772.8
22" x 1-3/4"	22	7/8	78.5	10	1	72.5	3.5	12	11	9	92	927.1
22" x 1-7/8"	22	1	84.5	10	1	78.5	3.5	13	12	10	100	1067.3
22" x 2"	22	1	84.5	10	1-1/8	84.5	3.5	13	13	11	104	1165.1
22" x 2-1/8"	22	1-1/8	90.5	10	1-1/8	90.5	3.5	14	14	12	112	1319.0
22" x 2-1/4"	22	1-1/8	90.5	10	1-1/4	90.5	3.5	14	14	13	116	1386.9
23" x 3/4"	23	3/8	42.5	10.5	1/2	36.5	3.75	6	5	3	44	254.4
23" x 7/8"	23	1/2	42.5	10.5	1/2	42.5	3.75	6	6	4	48	310.7
23" x 1"	23	1/2	48.5	10.5	5/8	48.5	3.75	7	7	5	56	391.9
23" x 1-1/8"	23	5/8	66.5	10.5	5/8	66.5	3.75	10	10	8	80	594.6
23" x 1-1/4"	23	5/8	54.5	10.5	3/4	54.5	3.75	8	8	7	68	530.2
23" x 1-3/8"	23	3/4	60.5	10.5	3/4	60.5	3.75	9	9	8	76	638.3
23" x 1-1/2"	23	3/4	72.5	10.5	7/8	66.5	3.75	11	10	8	84	780.9
23" x 1-5/8"	23	7/8	78.5	10.5	7/8	72.5	3.75	12	11	9	92	913.1
23" x 1-3/4"	23	7/8	78.5	10.5	1	78.5	3.75	12	12	10	96	1006.6
23" x 1-7/8"	23	1	84.5	10.5	1	84.5	3.75	13	13	11	104	1153.1
23" x 2"	23	1	90.5	10.5	1-1/8	90.5	3.75	14	14	12	112	1302.9
23" x 2-1/8"	23	1-1/8	90.5	10.5	1-1/8	90.5	3.75	14	14	13	116	1380.5
23" x 2-1/4"	23	1-1/8	102.5	10.5	1-1/4	96.5	3.75	16	15	13	124	1588.2
24" x 3/4"	24	3/8	36.5	11	1/2	36.5	4	5	5	4	44	248.8
24" x 7/8"	24	1/2	48.5	11	1/2	42.5	4	7	6	4	52	347.0
24" x 1"	24	1/2	60.5	11	5/8	60.5	4	9	9	7	72	510.2
24" x 1-1/8"	24	5/8	72.5	11	5/8	66.5	4	11	10	8	84	647.5
24" x 1-1/4"	24	5/8	60.5	11	3/4	60.5	4	9	9	7	72	608.8
24" x 1-3/8"	24	3/4	66.5	11	3/4	66.5	4	10	10	8	80	726.6
24" x 1-1/2"	24	3/4	72.5	11	7/8	72.5	4	11	11	9	88	849.4
24" x 1-5/8"	24	7/8	78.5	11	7/8	78.5	4	12	12	10	96	987.2
24" x 1-3/4"	24	7/8	78.5	11	1	78.5	4	12	12	11	100	1052.2
24" x 1-7/8"	24	1	84.5	11	1	84.5	4	13	13	12	108	1204.8
24" x 2"	24	1	96.5	11	1-1/8	90.5	4	15	14	12	116	1402.1
24" x 2-1/8"	24	1-1/8	102.5	11	1-1/8	96.5	4	16	15	13	124	1579.8
24" x 2-1/4"	24	1-1/8	108.5	11	1-1/4	102.5	4	17	16	14	132	1755.4

2.3 Field Web Splice - Bolted

General

Splices shall be designed using the Service Load Design Method and in accordance with AASHTO Articles 10.18, 10.24 and 10.32 except as noted.

The web splice consists of 2-Plates:

Thickness = 5/16" minimum.

Width = 12-1/2" (18-1/2" if 3 rows of bolts are required).

When the web section or steel grade changes at a splice, the smaller web strength should be used to design the splice.

Minimum Yield Strength (F_y) and Minimum Tensile Strength (F_u)

ASTM A709 Grade 36	$F_y = 36$ ksi	$F_u = 58$ ksi
ASTM A709 Grade 50	$F_y = 50$ ksi	$F_u = 65$ ksi
ASTM A709 Grade 50W	$F_y = 50$ ksi	$F_u = 70$ ksi

Allowable Steel Stresses (F_b , F_v)

Allowable stresses are determined from AASHTO Table 10.32.1A.

Allowable bending stress	$F_b = 0.55 \times F_y$
Allowable shear stress	$F_v = 0.33 \times F_y$

ASTM A709 Grade 36	$F_b = 20$ ksi	$F_v = 12$ ksi
ASTM A709 Grade 50	$F_b = 27$ ksi	$F_v = 17$ ksi
ASTM A709 Grade 50W	$F_b = 27$ ksi	$F_v = 17$ ksi

Allowable Bolt Stresses

Although standard holes are used in the fabrication of web splices, designing the splices for oversize holes allows for some fabrication and erection tolerances. Web splices required to resist shear between their connected parts are designated as slip-critical connections. Shear connections subjected to stress reversal, or where slippage would be undesirable, shall be slip-critical connections. Potential slip of joints should be investigated at intermediate load stages especially those joints located in composite regions. The resultant force shall be less than the allowable bolt shear force. All splice bolts shall be A325 7/8" diameter High Strength Bolts.

$F_v = 19$ ksi

Bolt Arrangement

The minimum distance from the center of any fastener in a standard hole to a sheared or thermally cut edge shall be 1-1/2 inches for 7/8" diameter fasteners. The minimum distance between centers of fasteners in standard holes shall be three times the diameter of the fastener, but shall not be less than 3 inches for 7/8" diameter fasteners.

Splice Plate Strength

The strength of the splice plates shall be determined by multiplying the allowable stress of the splice plates by the net area of all splice plates. The splice plates net area shall be taken as the gross area of the splice plates minus the bolt holes. Bolt holes are considered to be 1 inch diameter for the purpose of determining splice plate net area. Web splices are designed to develop 75% of net section of the web.

Web Strength

The strength of the web should be determined from the allowable web stress at the "top of web" to account for hybrid sections. Otherwise, the allowable web stress is based on a linear distribution of stress from outside face of flange to "top of web".

Weight of Splice

When calculating the weight of splice, the following simplified weights shall be used.

Weight of High-Strength bolts (diameter 7/8") = 0.95 lbs/bolt

Unit weight of Structural Steel = 490 lbs/ft³

Field Web Splice Table

The dimensions of web splices shown in the table are based on the assumption that the demand shear force is equal to half of the web shear capacity ($0.5V_{cap}$) and the demand moment is equal to half of the web moment capacity ($0.5M_{cap}$). If the actual demand shear force (V_{act}) and/or actual demand moment (M_{act}) are/is greater than $0.5V_{cap}$ and/or $0.5M_{cap}$, the standard design procedure as shown in the following design example shall be used to design the web splice.

Web Depth Inches	A	B spaces	C	D spaces	E	Wt./Splice With 7/8" Bolts	Maximum Web Thickness	
							Grade 36	Grade 50/50W
36	33"	2	5"	2	5"	100	5/8"	7/16"
42	39"	2	4"	4	5"	121	11/16"	1/2"
48	45"	1	3.5"	7	5"	138	11/16"	1/2"
54	51"	1	4"	8	5"	155	11/16"	1/2"
60	57"	1	4.5"	9	5"	172	5/8"	7/16"
66	63"	4	5"	4	5"	189	5/8"	7/16"
72	69"	2	4"	10	5"	210	11/16"	1/2"
78	75"	1	3.5"	13	5"	227	11/16"	1/2"
84	81"	1	4"	14	5"	244	5/8"	7/16"
90	87"	1	4.5"	15	5"	261	5/8"	7/16"
96	93"	6	5"	6	5"	278	5/8"	7/16"

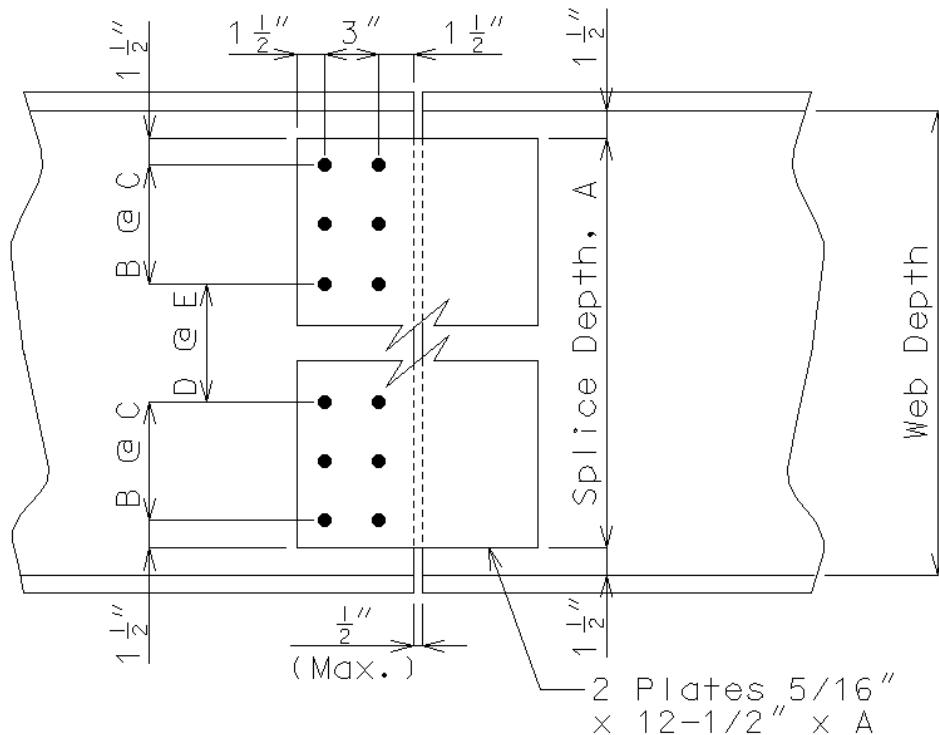


Figure 3.42.2.3-1

Notes: Provide shim plates when connecting webs that differ in thickness by $1/8"$ or more. Use equal number of shim plates on each side of web. The minimum thickness of shim plate is $1/16"$. Uniformity of web plate thicknesses which would eliminate the need for the minimum thickness of shim plate should also be considered.

Design Example

Web, flange, and splice plate made of A709 Grade 36 steel.

Web dimensions are 36 inches x 0.625 inches.

Splice consists of 7/8" diameter A325 high strength bolts as shown in Figure 3.42.2.3-2.

Web and plate allowable bending stress

$$F_b = 20 \text{ ksi}$$

Web and plate allowable shear stress

$$F_v = 12 \text{ ksi}$$

Assumptions

- 1 For the placement of the neutral axis, it is assumed that the top and bottom flange are of equal size. This will allow the neutral axis of the splice to correspond to the neutral axis of the girder.
- 2 The splice is placed at or near the point of DL1 contraflexure. This will allow us to make certain assumptions about the actual moment carried through the splice.
- 3 From structural analysis, actual shear load and moment at the splice are given as 100 kips and 43 kip-ft.

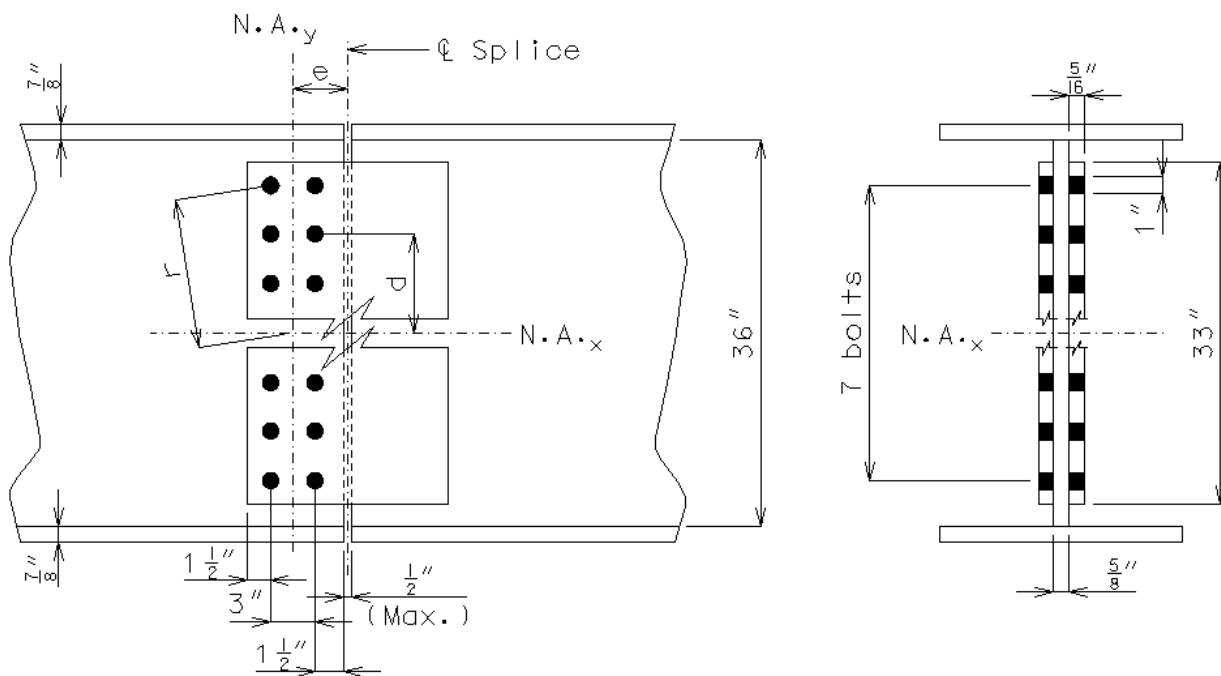


Figure 3.42.2.3-2

Net Cross-Sectional Properties of Web

Distance from neutral axis to the point of extreme fiber in bending

$$\bullet \quad C_{web} = 36''/2 = 18''$$

d = the distance from the neutral axis to the center of bolt

$$\bullet \quad \sum_{i=1}^7 d_{Y_i}^2 = 0^2 + 2 \times (5^2 + 10^2 + 15^2) = 700 \text{ in}^2$$

Net Inertia of Web

$$\bullet \quad I_{web}(net) = \frac{(0.625'')(36'')^3}{12} - (0.625'' \times 1.0'') \left(\sum_{i=1}^7 d_{Y_i}^2 \right) = 1992.5 \text{ in}^4$$

Net Section Modulus of the Web

$$\bullet \quad S_{web}(net) = \frac{I_{web}(net)}{C_{web}} = \frac{1992.5 \text{ in}^4}{18''} = 110.69 \text{ in}^3$$

Allowable stress at top and bottom of web

$$\bullet \quad F_s = \frac{36''}{36'' + 2(0.875'')} \times (20 \text{ ksi}) = 19.07 \text{ ksi}$$

Gross Cross-sectional Properties of Splice Plates

Height of splice = 33", thickness of splice = 0.3125"

Distance from the neutral axis to the point of extreme fiber in bending

$$\bullet \quad C_{splice} = (\text{Splice height})/2 = 33''/2 = 16.5''$$

Gross cross-sectional area of two plates

$$\bullet \quad A_g = (33'') \times (0.3125'') \times (2 \text{ plates}) = 20.625 \text{ in}^2$$

Gross Inertia of plates about their N.A.

$$\bullet \quad I_g = \frac{(0.3125'') \times (33'')^3}{12} \times (2 \text{ plates}) = 1871.7 \text{ in}^4$$

Gross Inertia of plates about N.A. of plate girder (For the case where the N.A. of the section does not fall at the geometric centroid of the section.)

$$\bullet \quad I_{g \text{ N.A.}} = 1871.7 \text{ in}^4 + (20.625 \text{ in}^2 \times 0) = 1871.7 \text{ in}^4$$

Section Modulus

$$\bullet \quad S_g = \frac{I_{g \text{ N.A.}}}{C_{splice}} = \frac{1871.7 \text{ in}^4}{16.5''} = 113.44 \text{ in}^3$$

Net Section Properties of Splice Plates

Net area of two splice plates

- $A_n = 20.625 \text{ in}^2 - (1\text") \times (0.3125\text") \times (7 \text{ bolts}) \times (2 \text{ plates}) = 16.25 \text{ in}^2$

Inertia loss due to the bolt holes in the plates

- $\sum_{i=1}^7 (A_{Hole} \times d_{Y_i}^2) = (0.625\text") \times (1\text") \times (700 \text{ in}^2) = 437.5 \text{ in}^4$

Net inertia of the splice plates

- $I_{splice(net)} = (1871.7 \text{ in}^4) - (437.5 \text{ in}^4) = 1434.2 \text{ in}^4$

Net Section Modulus of Splice Plates

- $S_{splice}(\text{net}) = \frac{I_{splice}(\text{net})}{C_{splice}} = \frac{1434.2 \text{ in}^4}{16.5\text"} = 86.92 \text{ in}^3$

Web Capacity

Maximum Web Moment Capacity

- $M_{cap(web)} = F_s \times S_{web}(\text{net})$
 $= (19.07 \text{ ksi}) (110.69 \text{ in}^3)$
 $= 175.9 \text{ kip-ft}$

Maximum Web Shear Capacity

- $V_{cap(web)} = F_V \times A_{web}(\text{net})$
 $= (12 \text{ ksi}) (0.625\text") \times (36\text"-7 \times 1.0\text")$
 $= 217.5 \text{ kips}$

$V_{act} = 100 \text{ kips} \text{ (Given)}$

Based on AASHTO 10.18.1.1 the design value used for shear shall not be less than the average of the actual shear and the shear capacity of the section, and in no case less than 0.75 times the capacity of the section.

- $V_{Design} = \left[\frac{V_{act} + V_{cap}}{2} \right] \geq 0.75V_{cap}$
 $V_{Design} = \frac{(217.5 \text{ kips} + 100 \text{ kips})}{2} = 158.75 \text{ kips}$
 or $= 0.75(V_{cap}) = (0.75)(217.5 \text{ kips}) = 163.1 \text{ kips}$
Use 163.1 kips

Eccentricity of shear load to centroid of bolt group

- $e = 1.5\text" + (0.5)(0.5\text") + (0.5)(3\text") = 3.25\text"$

Moment on splice induced by shear eccentricity

- $M_e = V_{act} \times e$
 $= (100 \text{ kips}) \times (3.25\text")$
 $= 27.1 \text{ kip-ft}$

Design Moment for Splice Plates

Web splice plates and their connections shall be designed for the portion of the actual design moment resisted by the web and for the moment due to eccentricity of the shear introduced by the splice connection. In our cases we have assumed the splice to be placed at the point of contraflexure and therefore the actual moment would be zero. In the case where the splice is not placed at exactly the point of contraflexure,

- $M_{Design} = \frac{(M_{act} + M_e) + M_{cap}}{2} = \frac{43 + 27.1 + 175.9}{2} = 123.0 \text{ kip-ft.}$

AASHTO 10.18.1.1 states that splices shall be designed in no case for less than $0.75 \times M_{cap}$

$$= (0.75)(175.9 \text{ kip-ft}) = 131.93 \text{ kip-ft}$$

$131.93 \text{ kip-ft} > 123.0 \text{ kip-ft, Therefore}$

Use $M_{Design} = 131.93 \text{ kip-ft}$

Check of Bolt Stresses

Polar Moment of Inertia of the bolt group

- $I_{Bolt Group} = I_y + I_x$
 $I_{Bolt Group} = (A_{Bolt})[2 \times 7 \times (1.5")^2 + 2 \times (700 \text{ in}^2)] = (A_{Bolt})(1431.5 \text{ in}^2)$

Radial distance from the centroid of bolt group to the farthest bolt

- $r = \sqrt{(1.5")^2 + \left(\frac{33"}{2} - 1.5"\right)^2} = 15.07"$

Shear Force on Bolt Due to Design Moment

- $V_m = f_b A_{Bolt} = \frac{M_{Design} \times r}{I_{Bolt Group}} \times A_{Bolt}$
 $= \frac{(131.93 \text{ kips-ft}) (15.07") (A_{Bolt})}{(1431.5 \text{ in}^2) (A_{Bolt})}$
 $= 16.50 \text{ kips}$

Shear Force on Bolt Due to Transferred Shear Load

- $V_s = \frac{V_{Design}}{\#bolts}$
 $= \frac{163.1 \text{ kips}}{14 \text{ bolts}}$
 $= 11.65 \text{ kips/bolt}$

Total vertical force on Bolt

- $V_t = V_s + V_{my}$
 $= (11.65 \text{ kips}) + (16.50 \text{ kips}) \left(\frac{1.5"}{15.07"} \right)$
 $= 13.29 \text{ kips}$

Bridge Manual

Welded Plate Girders – Section 3.42

Page: 2.3-8

Field Web Splice - Bolted

Details

Horizontal Force on Bolt

$$\bullet \quad V_{mx} = (16.50 \text{ kips}) \left(\frac{15''}{15.07''} \right) \\ = 16.42 \text{ kips}$$

Resultant Force on Bolt

$$\bullet \quad V_r = \sqrt{(V_{mx})^2 + (V_{my} + V_s)^2} = \sqrt{(16.42 \text{ kips})^2 + (13.29 \text{ kips})^2} \\ = 21.13 \text{ kips}$$

Allowable Shear Force on Bolt

$$\bullet \quad V_r = (19 \text{ ksi}) \times \left[\pi \left(\frac{0.875''}{2} \right)^2 \right] \times 2 \text{ (for double shear)} \\ = 22.85 \text{ kips}$$

22.85 kips > 21.13 kips

Therefore, shear force in bolts OK!

Check of Shear Stress Check on Splice Plates

Shear Stress on Net Section

$$\bullet \quad f_V = \frac{V_{Design}}{A_{net}} \\ = \frac{163.1 \text{ kips}}{16.25 \text{ in}^2} \\ = 10.04 \text{ ksi}$$

Allowable Shear Stress of Plate Steel

$$\bullet \quad F_V = 12 \text{ ksi}$$

12 ksi > 10.04 ksi

Therefore, shear stress in plates OK!

Check of Bending Stress Check on Splice Plates

Gross Plate Section

$$\begin{aligned}\bullet \quad f_{bg} &= \frac{M_{Design}}{S_g} \\ &= \frac{131.93 \text{ kip-ft}}{113.44 \text{ in}^3} \\ &= 13.96 \text{ ksi}\end{aligned}$$

Allowable Bending Stress of Gross Plate Steel

$$\bullet \quad F_{allow} = (20.0 \text{ ksi}) \times \left[\frac{16.5''}{18.875''} \right] = 17.31 \text{ ksi}$$

17.31 ksi > 13.96 ksi

Therefore, bending stress in plates OK!

Net Plate Section

$$\bullet \quad f_{bn} = \frac{131.93 \text{ kip-ft}}{86.92 \text{ in}^3} = 18.21 \text{ ksi}$$

Allowable Bending Stress of Net Plate Steel (AASHTO 10.18.1.1)

$$\bullet \quad F_{all(net)} = 0.5F_u \left(\frac{16.5}{18.75} \right) \\ = (0.5)(58 \text{ ksi}) \left(\frac{16.5}{18.875} \right) = 25.35 \text{ ksi}$$

25.35 ksi > 18.21 ksi

Therefore, bending stress in plates OK!

Weight of Splice

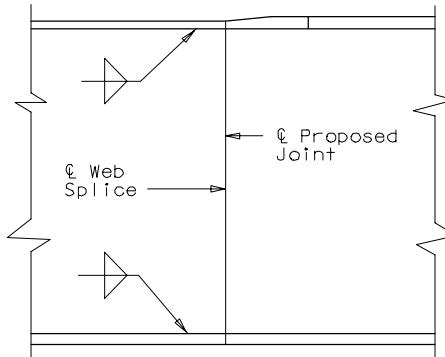
$$\begin{aligned}&= (\#rows)(\#bolts)(wt.bolts) + (2 \text{ plates})(thickness)(width)(depth)(density) \\ &= (4)(7)(0.95 \text{ lb/bolt}) + (2 \text{ plates})(0.3125'')(12.5'')(33'')(490 \text{ lb/ft}^3) \\ &= 26.6 \text{ lbs} + 73.1 \text{ lbs} \\ &= \underline{\underline{99.7 \text{ lbs per splice}}}\end{aligned}$$

Splice Welding Details**Details**

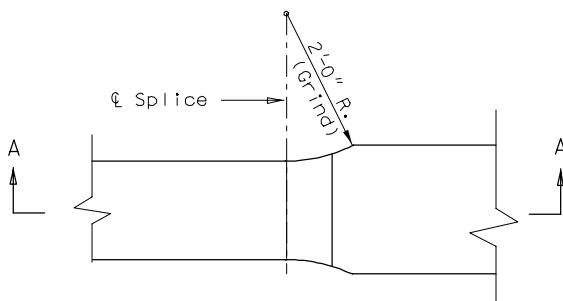
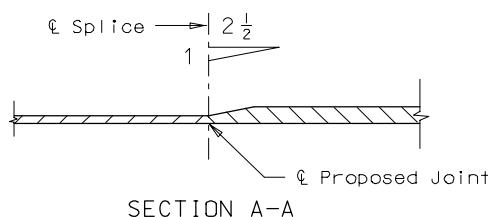
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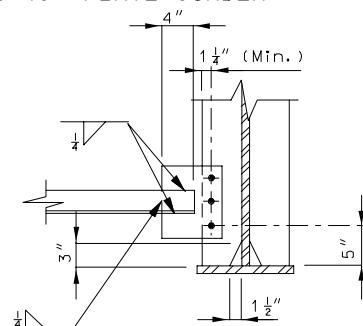
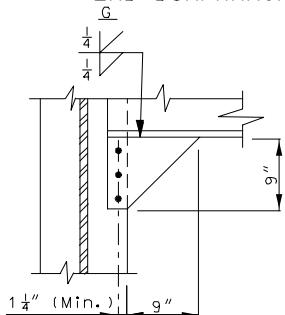
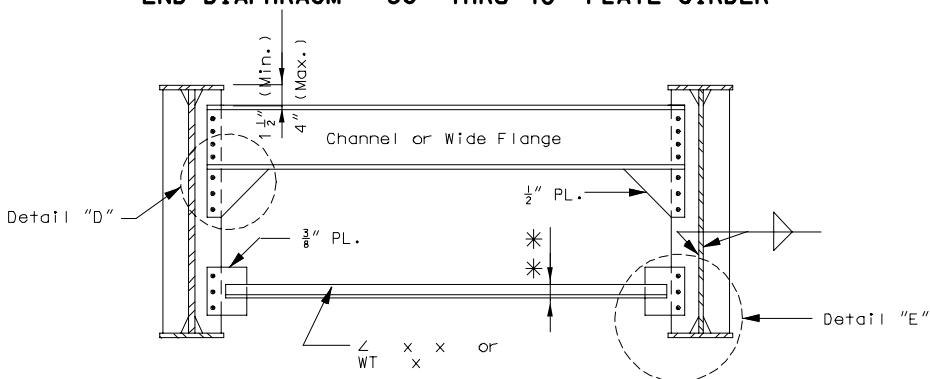
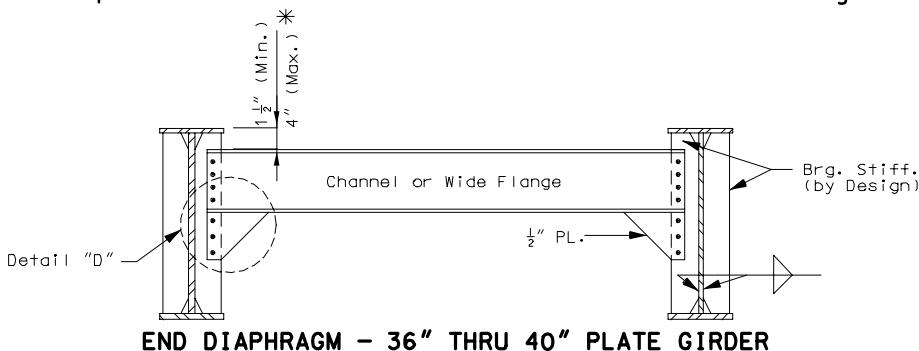
AASHTO Figure 10.18.5A

The following details and note shall be provided on all plate girder bridges.



NOTE:
Welded shop web and flange splices may be permitted when detailed on the shop drawings and approved by the engineer. No additional payment will be made for optional welded shop web and flange splices.

WELDED SHOP WEB SPLICE**PLAN
2'-0" RADIUS TRANSITION****SECTION A-A
WELDED SHOP FLANGE SPLICE**



Note: See tables in this section for size of diaphragm members and weight of diaphragms.

See details in this section for welding bearing stiffeners.

For End Diaphragms, haunch slab to bear.

* Slope diaphragms when a structure is superelevated or when the 4" maximum depth is exceeded.

** Detailer to show dimension on plans (Unequal angles only).

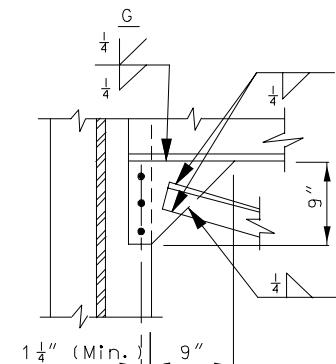
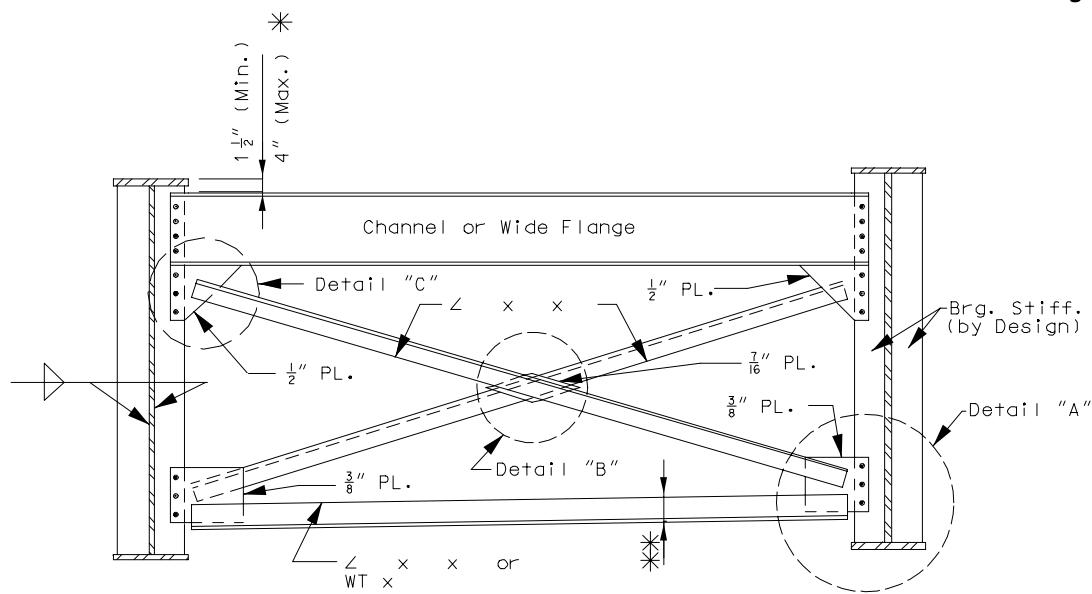
Bridge Manual

Welded Plate Girders - Section 3.42

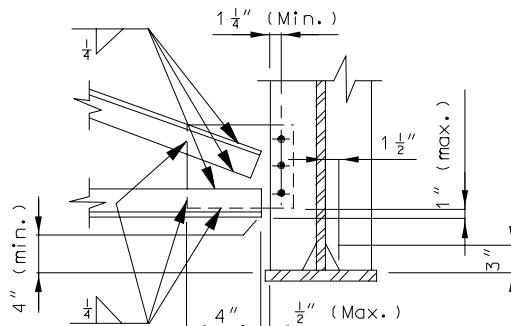
Page: 3.1-2

End Diaphs. - Plate Girders (over 48")

Bracing Details



DETAIL "C"



DETAIL "A"

Note: See tables in this section for size of diaphragm members and weight of diaphragms.

See details in this section for welding bearing stiffeners.

For Detail "B", see this section page 3.2-1.

For End Diaphragms, haunch slab to bear.

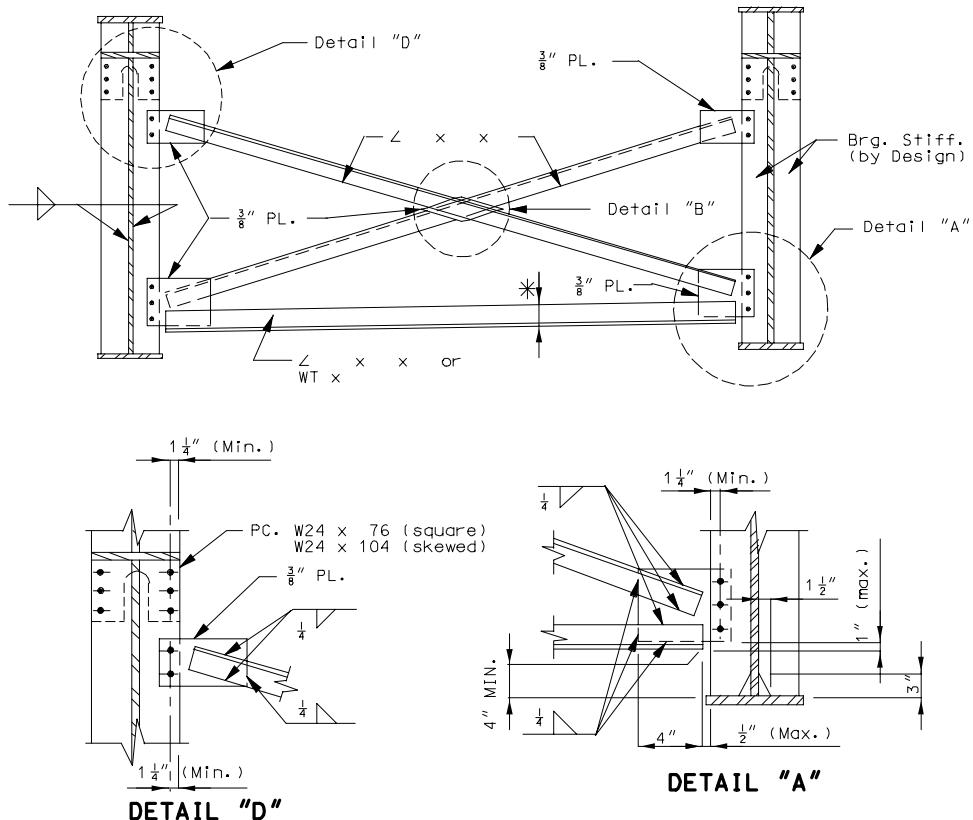
* Slope diaphragms when a structure is superelevated or when the 4" maximum depth is exceeded.

** Detailer to show dimension on plans (Unequal angles only).

End Diaphs.-Plate Girders (over 48")

Structures with Finger Plate Expansion Device:

Bracing Details



Note: See tables in this section for size of diaphragm members.

See details in this section for welding bearing stiffeners.

For Detail "B", see this section page 3.2-1.

* Detailer to show dimension on plans (Unequal angles only).

Revised: Nov. 1999

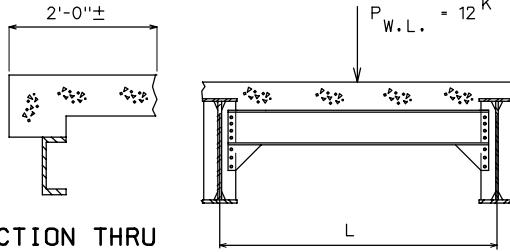
H & HS15 LOADING $F_y = 36 \text{ KSI}$ $W = 2 \text{ ft. of slab + Diaphragm Weight}$

$$M_{DL} = \frac{wL^2}{8}$$

$$M_{LL+I} = 1.3 \times P \times L/4$$

$$M_{MAX.} = F_y \times S_{X-X}$$

$$M_U = 1.3(M_{DL} + \frac{5}{3} M_{LL+I})$$



STANDARD END DIAPHRAGMS								
GDR. SPA.	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-4"	9'-8"
SKEW	SIZE AND WEIGHT							
0°	C12 x 25	C12 x 25	C12 x 25	C12 x 25	C12 x 30	C12 x 30	C15x33.9	C15x33.9
10°	C12 x 25	C12 x 25	C12 x 25	C12 x 25	C12 x 30	C12 x 30	C15x33.9	C15x33.9
20°	C12 x 25	C12 x 25	C12 x 30	C12 x 30	C12 x 30	C15x33.9	C15x33.9	C15x33.9
30°	C12 x 30	C12 x 30	C12 x 30	C12 x 30	C15x33.9	C15x33.9	C15x33.9	C15x33.9
40°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9
50°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	W16 x 36	W16 x 36
60°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 40	W16 x 40

Diaphragms are designed as simple span with a $8\frac{1}{2}$ " slab.

For Seismic Categories B, C, & D, a more detailed analysis is required.

Revised: Nov. 1999

H & HS20 LOADING

$$F_y = 36 \text{ KSI}$$

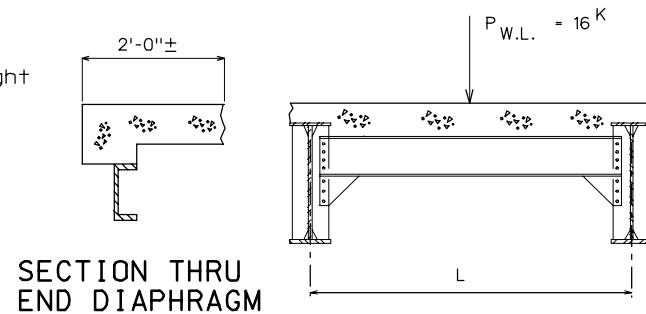
$W = 2 \text{ ft. of slab + Diaphragm Weight}$

$$M_{DL} = \frac{WL^2}{8}$$

$$M_{LL+I} = 1.3 \times P \times L/4$$

$$M_{MAX.} = F_y \times S_{X-X}$$

$$M_U = 1.3(M_{DL} + \frac{5}{3} M_{LL+I})$$



STANDARD END DIAPHRAGMS								
GDR. SPA.	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-4"	9'-8"
SKEW	SIZE AND WEIGHT							
0°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9
10°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9
20°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9
30°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	C15x33.9	W16 x 36	W16 x 36
40°	C15x33.9	C15x33.9	C15x33.9	C15x33.9	W16 x 36	W16 x 36	W16 x 36	W16 x 36
50°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 40	W16 x 40
60°	W16 x 40	W16 x 40	W16 x 40	W16 x 40	W18 x 46	W18 x 46	W18 x 46	W18 x 46

Diaphragms are designed as simple span with a $8\frac{1}{2}''$ slab.

For Seismic Categories B, C, & D, a more detailed analysis is required.

H & HS20 MODIFIED LOADING

$$F_y = 36 \text{ KSI}$$

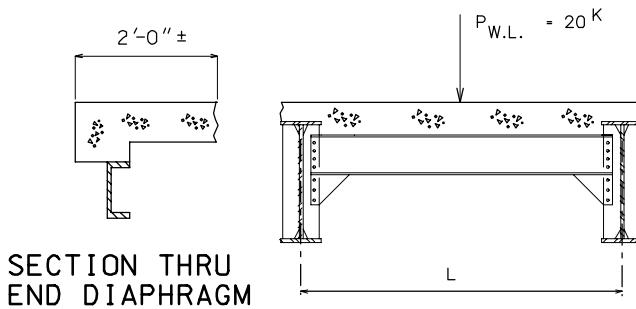
$W = 2 \text{ ft. of slab + Diaphragm Weight}$

$$M_{DL} = \frac{WL^2}{8}$$

$$M_{LL+I} = 1.3 \times P \times L/4$$

$$M_{MAX.} = F_y \times S_{X-X}$$

$$M_U = 1.3(M_{DL} + \frac{5}{3} M_{LL+I})$$



STANDARD END DIAPHRAGMS								
GDR. SPA.	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-4"	9'-8"
SKEW	SIZE AND WEIGHT							
0°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36
10°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36
20°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36
30°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36
40°	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W16 x 36	W18 x 46	W18 x 46
50°	W16 x 36	W16 x 36	W18 x 46					
60°	W18 x 46	W18 x 46	W18 x 46	W18 x 46	W18 x 55	W18 x 55	W18 x 55	W18 x 55

Diaphragms are designed as simple span with a $8\frac{1}{2}$ " slab.

For Seismic Categories B, C, & D, a more detailed analysis is required.

Horizontal member sizes (all girder depths)

Skew	Girder Spacing					
	7'-2"	7'-4"	7'-9" & 7'-10"	8'-4"	8'-10"	9'-9" & 9'-10"
Straight Girders						
0°	L 3x3x $\frac{5}{16}$	L 3x3x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x4x $\frac{5}{16}$
10°	L 3x3x $\frac{5}{16}$	L 3x3x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x4x $\frac{5}{16}$
20°	L 3x3x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x4x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$
30°	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x4x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$
40°	L 4x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x4x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$	L 6x6x $\frac{3}{8}$
50°	L 5x5x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$	L 5x5x $\frac{5}{16}$	L 6x6x $\frac{3}{8}$	L 6x6x $\frac{3}{8}$	WT 5x15
60°	L 6x6x $\frac{3}{8}$	L 6x6x $\frac{3}{8}$	WT 5x15	WT 5x15	WT 6x17.5	WT 7x21.5
Curved Girders						
0°	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x3 $\frac{1}{2}$ x $\frac{3}{8}$	L 4x4x $\frac{3}{8}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$
10°	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x3 $\frac{1}{2}$ x $\frac{3}{8}$	L 4x4x $\frac{3}{8}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$
20°	L 3 $\frac{1}{2}$ x3 $\frac{1}{2}$ x $\frac{5}{16}$	L 4x3 $\frac{1}{2}$ x $\frac{3}{8}$	L 4x4x $\frac{3}{8}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$
30°	L 4x4x $\frac{3}{8}$	L 4x4x $\frac{3}{8}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$	WT 5x15
40°	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$	L 5x5x $\frac{1}{2}$	WT 5x15	WT 5x15	WT 5x15
50°	WT 5x15	WT 6x17.5				
60°	WT 5x15	WT 6x17.5	WT 6x17.5	WT 7x21.5	WT 7x21.5	WT 7x26.5

Note: The members in this table for curved girders meet the requirements for main members (e.g., They are based on $KL/r \leq 120$). Resistance to torsion was not considered in their design.

The members in this table for straight girders meet the requirements for secondary member (e.g., They are based on $KL/r \leq 140$).

For horizontal member of Int. Diaph's and Cross Frames use skew angle of Int. Diaph. or Cross Frame and not skew of Bridge, e.g. For skews over 20° where Int. Diaph. is normal to girder, enter table with 0° skew.

For girder spacing or skews not listed in table, use nearest angle size.

Bridge Manual

Welded Plate Girders - Section 3.42

Page: 3.1-6

End Diaphragms Straight Girder (Over 48")

Bracing Details

Size of diagonal angles

Gdr. Spd.	Skew	Girder Depth				
		48"	60"	72"	84"	96"
7'-2"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16				
	60°	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3½x5/16
7'-4"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16				
	60°	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
7'-9"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16				
	60°	∠ 3½x3½x5/16				
7'-10"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16				
	60°	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 4x3½x5/16
8'-4"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16
	60°	∠ 3½x3½x5/16	∠ 4x3½x5/16	∠ 4x3½x5/16	∠ 4x3½x5/16	∠ 4x4x5/16
8'-10"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16
	60°	∠ 4x3½x5/16	∠ 4x4x5/16	∠ 4x4x5/16	∠ 4x4x5/16	∠ 4x4x5/16
9'-9"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
	60°	∠ 5x5x5/16				
9'-10"	0° -40°	∠ 3x3x5/16				
	50°	∠ 3½x3½x5/16				
	60°	∠ 5x5x5/16				

For horizontal members, see page 3.1-5.

Note: For girder spacing or skews not listed in table, use nearest angle size.

The members in this table for straight girders meet the requirements for secondary members (e.g. they are based on $KL/r \leq 140$).

Bridge Manual

Welded Plate Girders - Section 3.42

Page: 3.1-7

End Diaphragms Curved Girder (Over 48")

Bracing Details

Size of diagonal angles

Gdr. Spa.	Skew	Girder Depth				
		48"	60"	72"	84"	96"
7'-2"	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16				
	40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16
	60°	∠ 3½x3½x5/16	∠ 4x3½x3/8	∠ 4x3½x3/8	∠ 4x4x3/8	∠ 4x4x3/8
	0° - 20°	∠ 3x3x5/16				
7'-4"	30°	∠ 3x3x5/16				
	40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16
	60°	∠ 4x3½x3/8	∠ 4x3½x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8
	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16				
7'-9"	40°	∠ 3x3x5/16				
	50°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3½x5/16
	60°	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 5x5x1/2
	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16				
	40°	∠ 3x3x5/16				
7'-10"	50°	∠ 3x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
	60°	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 5x5x1/2
	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16				
	40°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16
	50°	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
8'-4"	60°	∠ 5x5x1/2				
	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16				
	40°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16
	50°	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
	60°	∠ 5x5x1/2				
8'-10"	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16				
	40°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16
	50°	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 4x3½x3/8	∠ 4x3½x3/8
	60°	∠ 5x5x1/2				
	0° - 20°	∠ 3x3x5/16				
9'-9"	30°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16
	40°	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
	50°	∠ 4x4x3/8				
	60°	∠ 5x5x1/2	∠ 5x5x1/2	∠ 5x5x1/2	∠ 5x5x1/2	∠ 6x6x1/2
	0° - 20°	∠ 3x3x5/16				
	30°	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3x3x5/16	∠ 3½x3x5/16	∠ 3½x3x5/16
9'-10"	40°	∠ 3½x3x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16	∠ 3½x3½x5/16
	50°	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 4x4x3/8	∠ 5x5x1/2
	60°	∠ 5x5x1/2	∠ 5x5x1/2	∠ 5x5x1/2	∠ 5x5x1/2	∠ 6x6x1/2

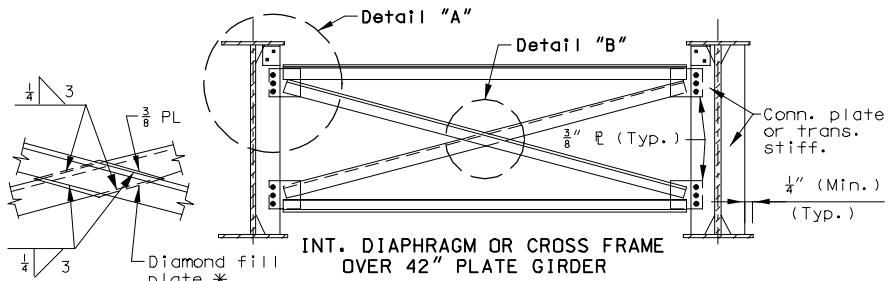
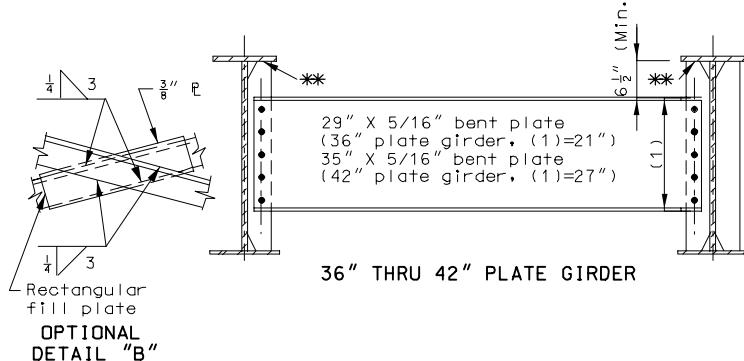
For horizontal members, see page 3.1-5.

Note: For girder spacing or skews not listed in table, use nearest angle size.

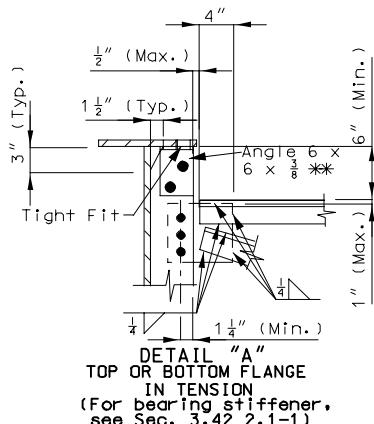
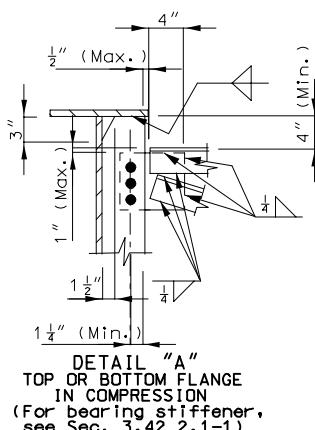
The angles in this table for curved girders meet the requirements for main members (e.g. They are based on $KL/r \leq 120$). Resistance to torsion was not considered in their design.

INTERMEDIATE DIAPHRAGMS & CROSS FRAMES

Bracing Details

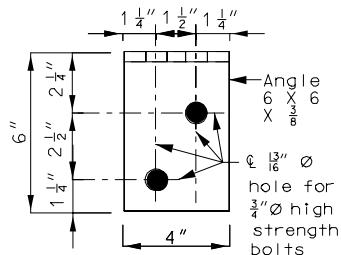


* At the contractor's option, rectangular fill plates may be used in lieu of diamond fill plates as shown in Optional Detail "B".

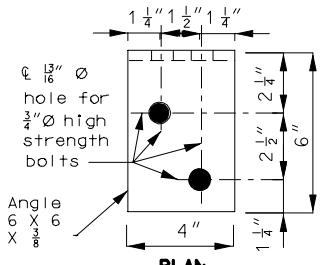


For horizontal member sizes, see page 3.1-5 in this section.

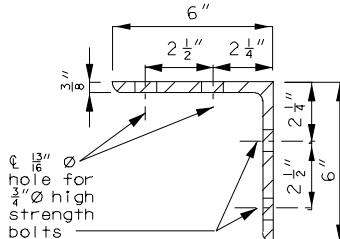
* Flange connection angle should be used on the tension flange with both intermediate diaphragms and cross frames. For positive flange connection of bearing stiffeners, see page 2.1-1. For Details of Flange Connection Angle, See page 3.2-2.



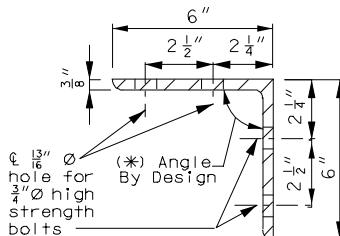
FRONT ELEVATION



PLAN



SECTION THRU ANGLE

SECTION THRU ANGLE
FOR ANGLES CONNECTED
TO BEARING STIFFENERS
ON BRIDGE WITH
VERTICAL GRADE

* - Angle legs shall be adjusted to conform to the variable angle between bearing stiffener and top flange created by the girder tilt requirement due to vertical grade.

DETAIL OF FLANGE CONNECTION ANGLE FOR INT. DIAPHRAGMS & CROSS FRAMES

See tables this section for the size of the angles and the weights of the diaphragms and cross frames.

See details in this section for the welding of diaphragm connection plates and bearing stiffeners.

Slope diaphragms and cross frames for excessive haunch or superelevation.

Size of Diagonal Angles (Girders over 42")

Straight Girders:

Web Depth thru 96"
Girder spacing thru 9'-10"
Skews thru 20° } Use angle 3 x 3 x $\frac{5}{16}$

Curved Girders:

Web Depth thru 96"
Girder spacing thru 9'-10"
Radial placement (0° skew) } Use angle 3 x 3 x $\frac{5}{16}$

The angle for curved girders meets the requirements for main members. It is based on $KL/R \leq 120$. Resistance to torsion was not considered in the design.

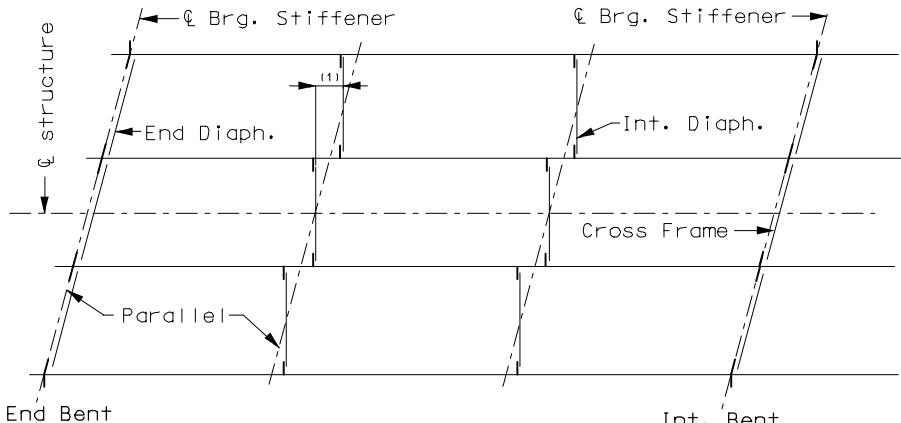
The angle for straight girders meets the requirements for secondary members. It is based on $KL/R \leq 140$.

See this section for the size of the horizontal angles.

Intermediate Diaphragms & Cross Frames

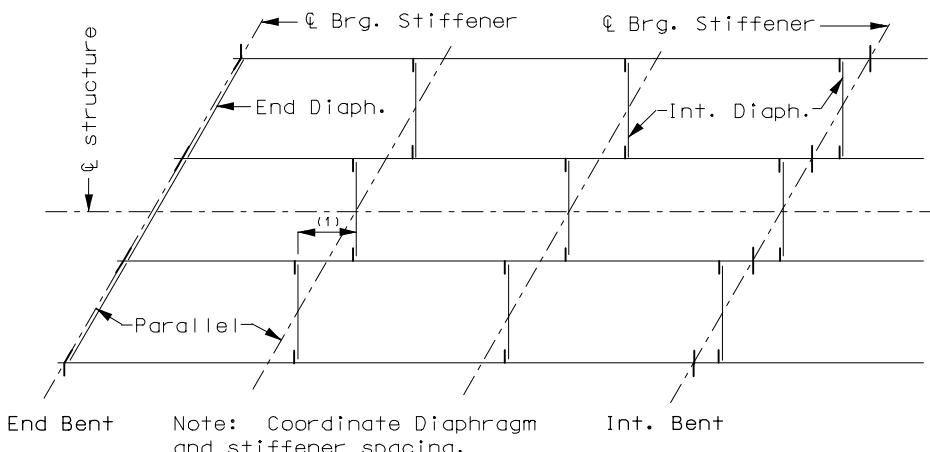
Bracing Details

Diaphragm spacing for straight girders



Note: Transverse stiffener spacing shall be identical on all girders.

Skews thru 20°



Note: Coordinate Diaphragm
and stiffener spacing.

Skews over 20°

(1) Tangent skew angle x girder spacing.

Note: Maximum Diaphragm spacing = 25'-0"

Check moments in diaphragms attached to bents
and near bents on skews of 45° or greater.

**Intermediate Diaphragms & Cross Frames
Diaphragm Spacing for Curved Girders****Bracing Details****Diaphragm Spacing:**

Maximum diaphragm spacing shall be 15'-0", unless determined otherwise for special designs.

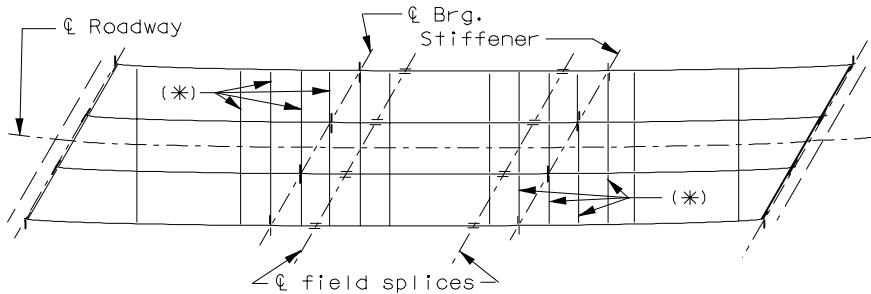
Diaphragm Positioning:

Diaphragms shall be spaced radially and in line, except in bridges having extreme skews. The proposed diaphragm layout shall be reviewed with the Structural Project Manager prior to detailing on the plans.

Location of Diaphragms:

Diaphragms must be located along the centerline of structure by the designer before sending a program to the computer. The Design Development Engineer will give assistance to the programming procedure, if desired.

The sketch shown below is an example of the desired diaphragm layout.

**PLAN OF STRUCTURAL STEEL**

(*) Many different spacing arrangements are possible. Attach to a bearing stiffener where practical.

Note: See details in this Section for attaching diaphragms to curved plate girder flanges.

Bridge Manual

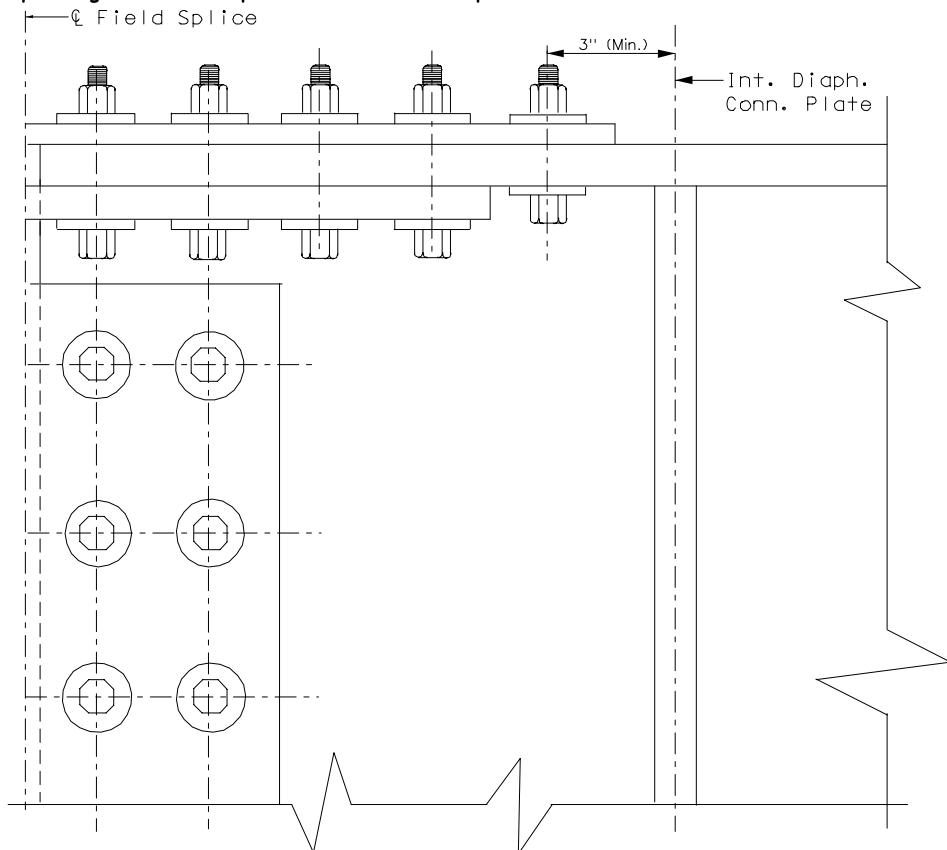
Welded Plate Girders - Section 3.42

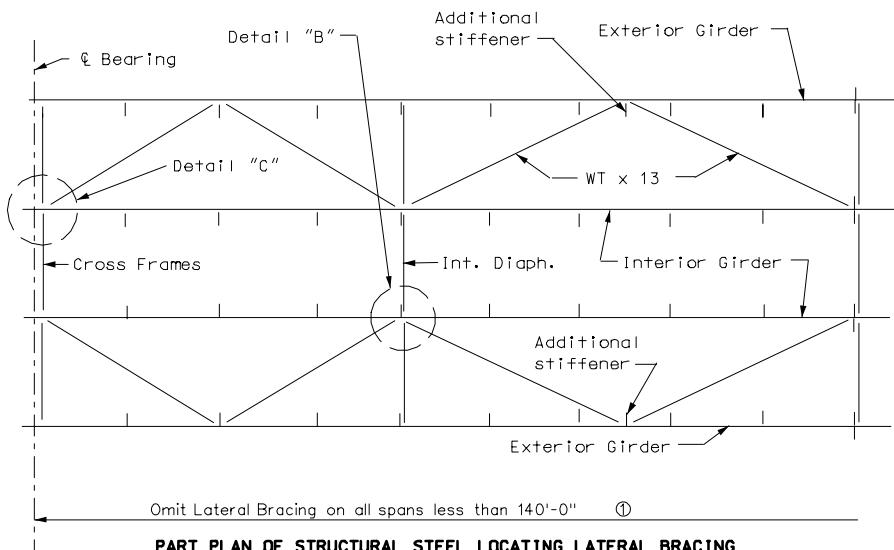
Page: 3.2-5

Intermediate Diaphragms & Cross Frames

Bracing Details

Spacing of Int. Diaphs. from Field Splice



Lateral Bracing**Bracing Details****PART PLAN OF STRUCTURAL STEEL LOCATING LATERAL BRACING**

Members selected shall meet requirements of secondary members with KL/R ratio of less than 140. Lateral Bracing is placed in outer bays.

The Plan of Structural Steel shall be detailed to accurately locate transverse web stiffener plates, girder splices, diaphragms and lateral bracing. This is necessary in order to provide adequate fabrication clearances between structural parts and to avoid unnecessary duplication of web stiffener plates and diaphragm connection plates.

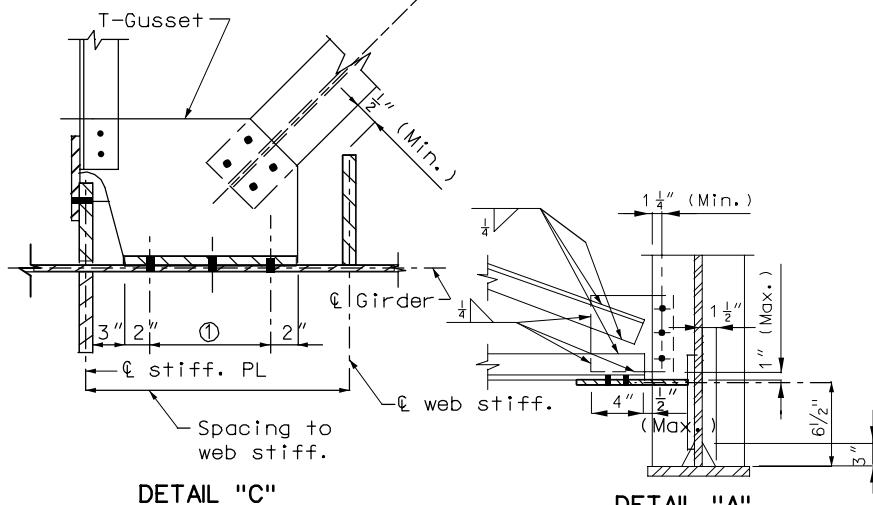
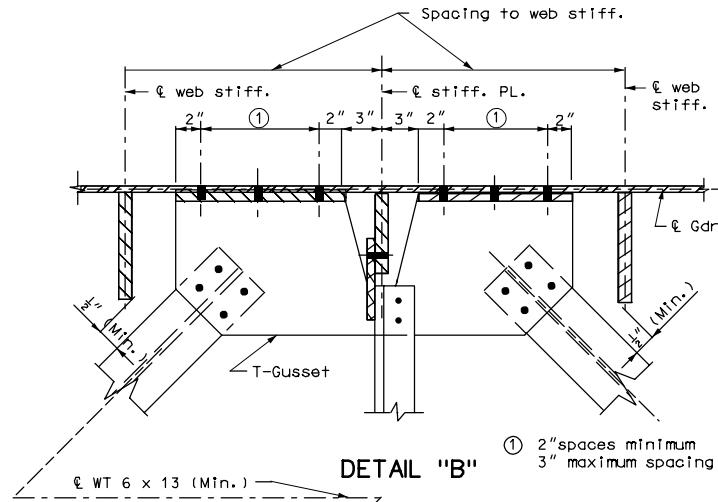
Under no circumstance shall lateral bracing be detailed to go thru diaphragms. In order to facilitate erection, structural tees for lateral bracing may be inverted to connect to the top gusset plates.

Whenever practicable, diaphragms and lateral bracing shall connect to bearing stiffeners in bridges having large skews. diaphragms and lateral bracing need not connect to end bearing stiffeners for such structures but should connect to a girder midway between the bearing stiffener and the first transverse web stiffener.

① Stress computations of lateral bracing required for spans greater than 140 ft. The lateral bracing may be omitted on longer spans if stresses and lateral wind loading computations are included with lower flange in accordance with AASHTO 10.21. Use 50 lbs. per sq. foot for wind load.

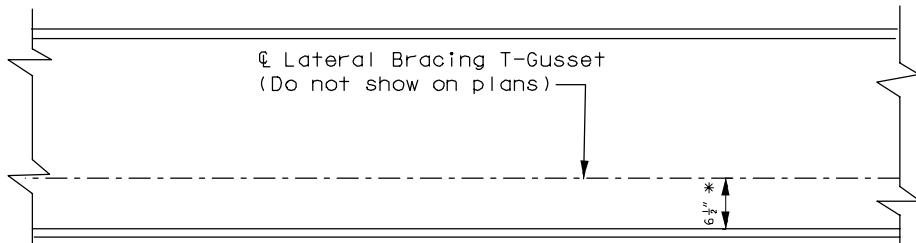
Lateral Bracing (cont.) Lateral Bracing T-Gusset Details

Bracing Details



For location of Detail
"A", see page 3.2-1.

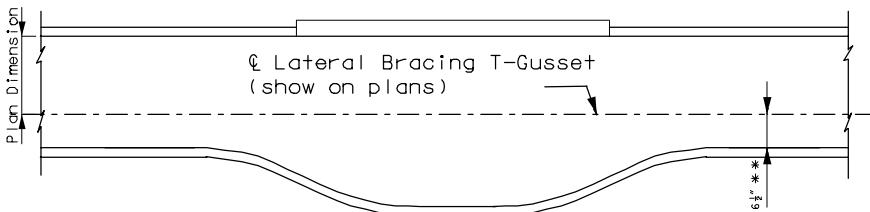
Note: Lateral Bracing T-Gusset shall be cut to required depth from W27 x 94, or T-Gusset can be built from plates in shop.

Lateral Bracing (cont.)**Bracing Details**

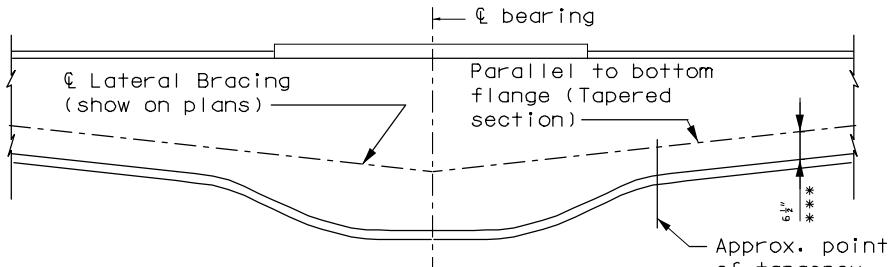
* Locate T-Gusset as shown above, dimension at all connections should be constant from top of bottom flange.

Place following note on plans:

Note: T-Gusset shall be placed _____ * inches above top of bottom flange.

CONSTANT DEPTH GIRDERS

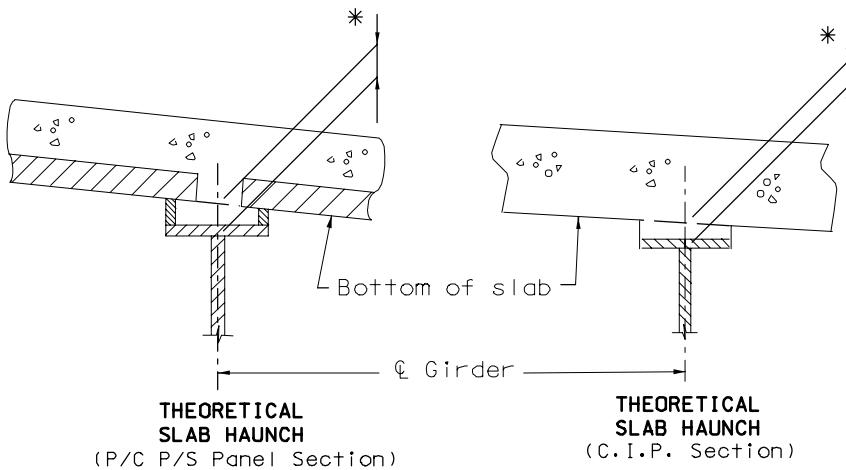
** Locate T-Gusset as shown above, dimension at all connections should be constant from top of bottom flange.

CONSTANT - VARIABLE DEPTH GIRDERS

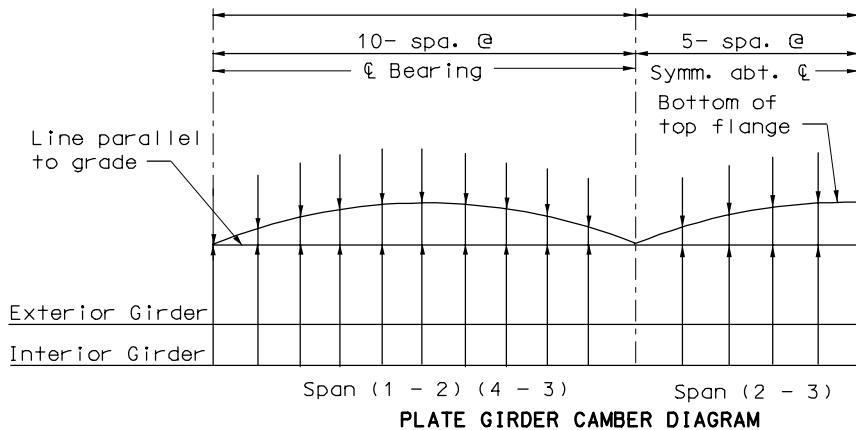
*** Locate T-Gusset as shown above, dimension at all connections thru tapered section should be constant from top of bottom flange (Slope T-Gusset same as bottom flange). Continue same slope thru variable depth section of girders.

TAPERED - VARIABLE DEPTH GIRDERS

Cambered Girder - Straight Grade (Dead Load Deflection) Misc. Details

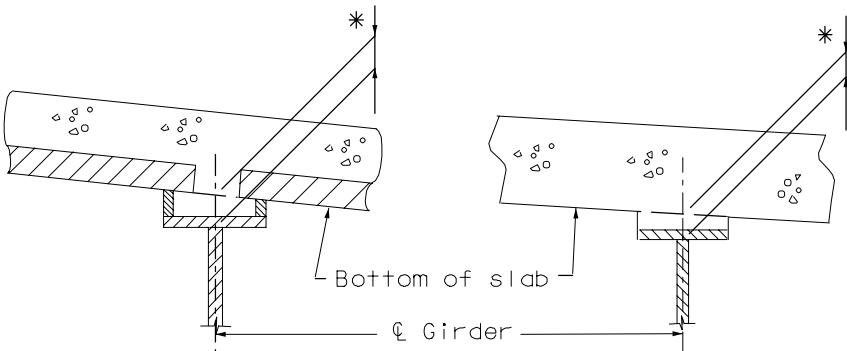


* Dimension (bottom of slab to top of web) may vary if girder camber after erection differs from plan camber by more than the % of Dead Load Deflection due to weight of structural steel. No payment will be made for additional forming or concrete required for variable haunching.



Note: Camber includes allowance for _____ * * _____
% of dead load deflection due to weight of structural steel.

* * See section 4 H for proper notes.

THEORETICAL SLAB HAUNCH
(P/C P/S Panel Section)THEORETICAL SLAB HAUNCH
(C.I.P. Section)

* Dimension (bottom of slab to top of web) may vary if girder camber after erection differs from plan camber by more than the % of dead load deflection due to weight of structural steel. No payment will be made for additional forming or concrete required for variable haunching.

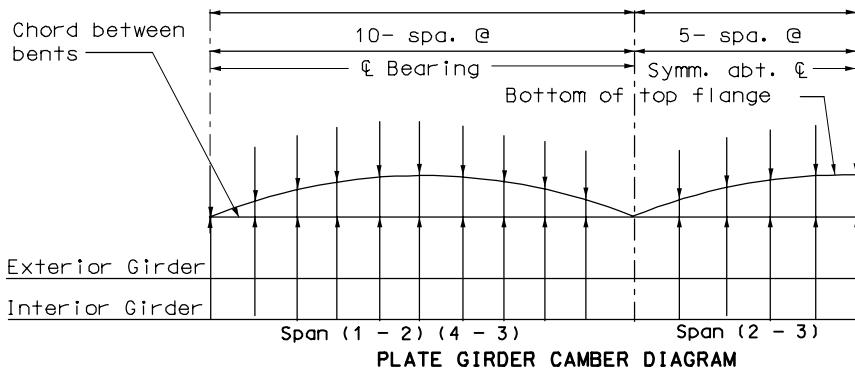
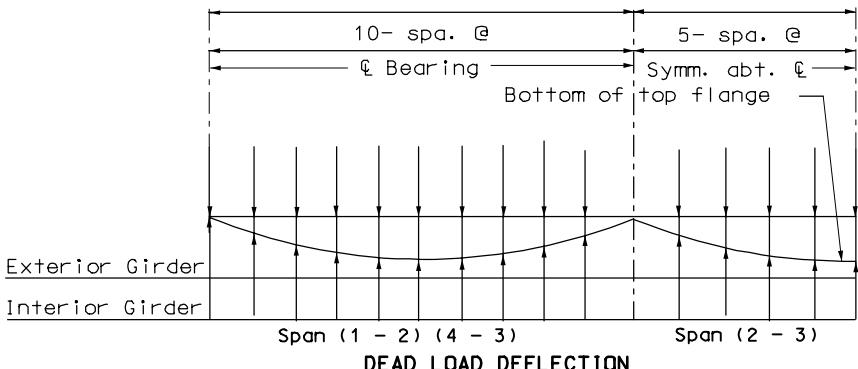


PLATE GIRDER CAMBER DIAGRAM



DEAD LOAD DEFLECTION

Note: Camber includes allowance for ** *

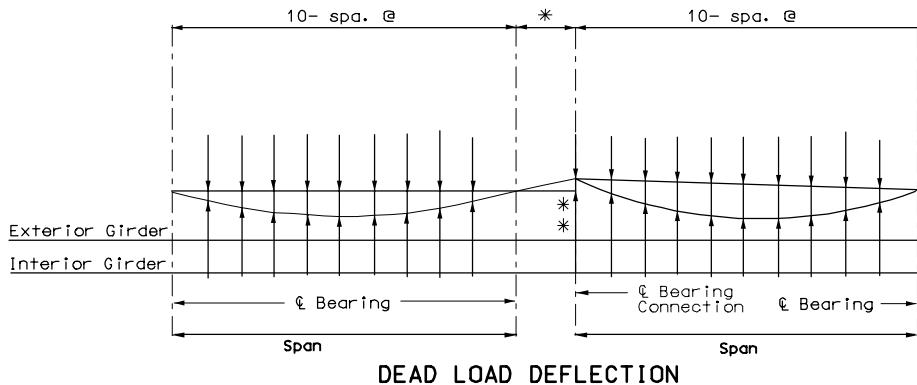
% of dead load deflection due to weight of structural steel.

** See section 4 H for proper notes.

Cambered Girder

Misc. Details

Plate Girder Dead Load Deflection for Bearing Connections (Pin Plate, Hinged or Hanger Connections)



Note: _____ % of dead load deflection due to weight of structural steel.

See Section 4 H for proper notes.

* 4 feet or greater.

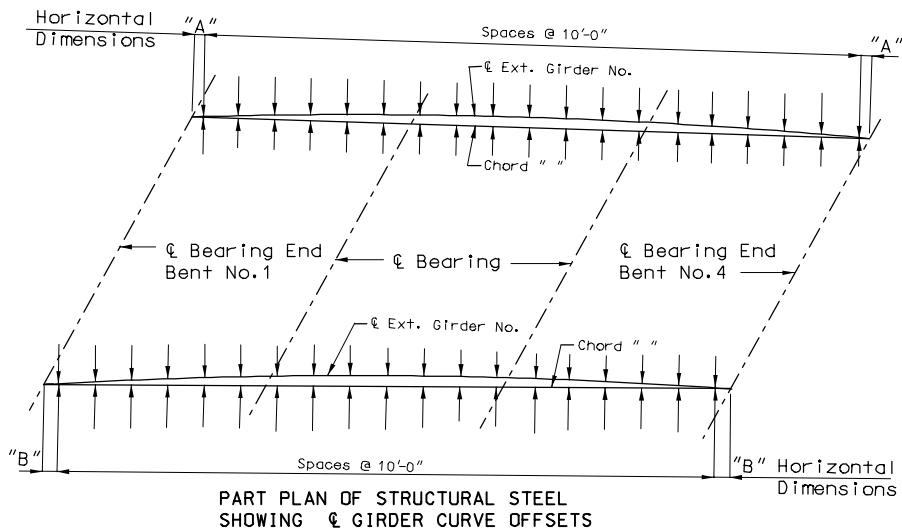
** This deflection should also be reflected in theoretical slab haunching or if girder is cambered in the camber.

Offsets for Curved Plate Girders

Misc. Details

Plans for structures having horizontally curved plate girders shall have the detail shown below placed near the plan of structural steel.

Designers when preparing the computer input for horizontal control should call for $\frac{1}{8}$ Exterior Girders Offsets.



Note: Typical example for 3 span structure shown.

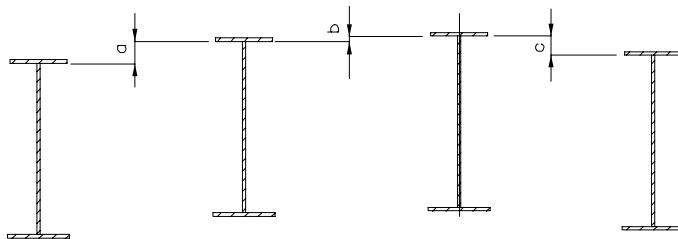
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Girder Elevation Variation Sketch

Misc. Details



SECTION THRU GIRDERS NORMAL TO C ROADWAY

Dimensions showing girder variations shall be placed on the cross section thru slab or, if necessary because of the number and type of variations, the above type of detail and table shall be placed near the structural steel layout.

Note: For details of Longitudinal Sections and Longitudinal Steel Diagram, see Section 3.30 (Longitudinal Diagrams).

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Weights for End Diaphragms
Straight Girders

Quantities

Skew	Girder Spacing							
	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-9"	9'-10"
36" Girder								
0°	168	172	181	182	193	203	262	265
10°	171	174	183	185	195	205	266	268
20°	178	182	191	193	204	254	328	331
30°	191	195	205	207	259	323	397	401
40°	253	258	321	324	343	407	447	451
50°	394	402	424	429	455	482	530	534
60°	502	513	541	547	615	651	717	723
42" and 48" Girders								
0°	226	230	245	247	265	279	354	357
10°	229	233	248	251	269	287	359	362
20°	238	247	263	265	280	343	446	449
30°	263	269	286	289	350	439	524	528
40°	337	349	435	440	466	536	643	648
50°	519	530	559	565	654	692	764	771
60°	721	737	780	789	872	966	1137	1146
60" Girder								
0°	308	314	333	337	360	379	465	469
10°	311	318	338	341	364	388	471	475
20°	323	334	355	358	379	447	560	565
30°	353	361	384	388	454	548	644	649
40°	433	447	538	544	578	654	773	780
50°	623	638	674	681	777	825	945	953
60°	870	877	947	957	1071	1194	1471	1484

Includes: Channel or Wideflange beam; Horizontal and Diagonal angles
(As required) Knee braces, all connection plates and bolts.

Note: Interpolate for skews not listed.

No Bearing Stiffeners of any kind included in the above table.

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Weights for End Diaphragms (Cont.)
Straight Girders (Cont.)

Quantities

Skew	Girder Spacing							
	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-9"	9'-10"
72" Girder								
0°	313	319	338	341	364	384	469	472
10°	317	323	342	346	369	393	475	479
20°	328	338	359	363	383	451	564	568
30°	358	365	388	392	458	551	647	652
40°	437	451	542	547	581	657	775	782
50°	626	641	677	684	780	827	947	955
60°	859	879	949	959	1072	1196	1471	1484
84" Girder								
0°	319	325	344	347	370	389	474	477
10°	323	329	348	351	375	398	480	483
20°	334	344	365	368	389	456	568	573
30°	363	371	393	397	463	556	651	656
40°	442	456	546	543	585	660	779	785
50°	630	644	680	688	783	844	950	958
60°	862	896	951	962	1075	1198	1474	1487
96" Girder								
0°	327	333	351	354	377	396	479	483
10°	330	336	355	358	381	404	486	489
20°	341	351	371	375	395	462	574	578
30°	370	377	399	403	469	561	656	661
40°	448	462	552	557	590	665	783	790
50°	635	649	685	692	801	848	954	962
60°	880	901	956	982	1095	1202	1478	1490

Includes: Channel or Wideflange beam; Horizontal and Diagonal angles
(As required) Knee braces, all connection plates and bolts.

Note: Interpolate for skews not listed.

No Bearing Stiffeners of any kind included in the above table.

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Weights for End Diaphragms (Cont.)

Quantities

Curved Girders

Skew	Girder Spacing							
	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-9"	9'-10"
36" Girder								
0°	168	172	181	182	193	203	262	265
10°	171	174	183	185	195	205	266	268
20°	178	182	191	193	204	254	328	331
30°	191	195	205	207	259	323	397	401
40°	253	258	321	324	343	407	447	451
50°	394	402	424	429	455	482	530	534
60°	502	513	541	547	615	651	717	723
42" and 48" Girders								
0°	233	237	262	265	285	351	426	429
10°	236	240	266	269	289	356	432	435
20°	245	264	282	285	353	411	502	506
30°	283	289	356	359	420	493	573	578
40°	409	418	490	495	513	587	645	650
50°	568	581	612	619	657	695	801	808
60°	724	775	818	827	974	1031	1232	1242
60" Girder								
0°	314	321	350	354	379	451	535	539
10°	318	325	355	358	384	457	542	547
20°	330	351	374	377	450	514	615	620
30°	372	380	451	455	522	601	692	698
40°	503	513	590	597	624	703	789	796
50°	669	685	725	745	806	855	1054	1063
60°	925	979	1055	1067	1425	1514	1769	1785

Includes: Channel or Wideflange beam; Horizontal and Diagonal angles
(As required) Knee braces, all connection plates and bolts.

Note: Interpolate for skews not listed.

No Bearing Stiffeners of any kind included in the above table.

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Weights for End Diaphragms (Cont.)
Curved Girder (Cont.)

Quantities

Skew	Girder Spacing							
	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-9"	9'-10"
72" Girder								
0°	319	326	355	359	384	455	539	543
10°	323	330	360	363	388	461	546	550
20°	335	355	378	382	454	518	619	624
30°	376	384	455	459	526	605	695	701
40°	506	518	594	600	627	706	804	811
50°	672	688	740	748	808	857	1057	1066
60°	927	999	1058	1070	1428	1517	1771	1787
84" Girder								
0°	326	332	361	364	389	460	544	547
10°	329	336	365	369	394	466	551	555
20°	341	361	384	387	459	523	623	628
30°	381	390	460	464	531	609	699	717
40°	511	522	598	605	631	722	808	815
50°	676	704	743	764	812	875	1061	1070
60°	948	1003	1062	1261	1434	1523	1776	1792
96" Girder								
0°	333	339	368	371	396	466	549	554
10°	337	343	372	375	400	472	557	561
20°	348	368	390	394	465	529	629	634
30°	388	396	466	470	537	615	717	722
40°	517	528	604	610	649	727	813	820
50°	693	709	761	769	817	919	1067	1268
60°	954	1009	1257	1270	1442	1530	1910	1927

Includes: Channel or Wideflange beam; Horizontal and Diagonal angles
(As required) Knee braces, all connection plates and bolts.

Note: Interpolate for skews not listed.

No Bearing Stiffeners of any kind included in the above table.

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**Weights for Int. Diaph. & Cross Frames
Straight Girders**

Quantities

Skew	Girder Spacing							
	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-9"	9'-10"
36" Girder								
0°	217	223	235	238	253	269	297	300
10°	221	226	239	242	257	273	302	304
20°	232	237	251	253	270	286	316	319
42" Girder								
0°	261	267	283	286	304	323	357	360
10°	265	271	287	290	309	328	363	366
20°	278	284	301	304	324	344	380	384
48" Girder								
0°	198	202	219	221	241	254	296	299
10°	201	204	222	224	244	266	300	303
20°	208	218	237	240	253	285	352	354
60" Girder								
0°	203	207	224	226	246	258	300	302
10°	205	209	226	228	248	270	304	306
20°	212	223	242	244	258	289	355	358
72" Girder								
0°	209	213	229	231	251	263	305	307
10°	212	215	232	233	254	275	309	311
20°	218	229	247	249	263	294	360	363
84" Girder								
0°	217	220	236	238	258	270	311	313
10°	219	222	239	240	260	281	314	316
20°	225	236	254	256	269	299	365	368
96" Girder								
0°	224	228	244	246	264	277	317	319
10°	226	230	246	248	267	288	321	323
20°	232	243	261	263	276	306	371	374

Includes: Channel or Wideflange beam; Horizontal and Diagonal angles
(As required) Knee braces, all connection plates and bolts.

Note: Interpolate for skews not listed.

No Bearing Stiffeners of any kind included in the above table.

Add 13 lbs to the values from the table for the weight of flange connection angles when the angles are used.

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Weights for Int. Diaphragms & Cross Frames
Curved Girder

Quantities

Skew	Girder Spacing							
	7'-2"	7'-4"	7'-9"	7'-10"	8'-4"	8'-10"	9'-9"	9'-10"
36" Girder								
0°	217	223	235	238	253	269	297	300
10°	221	226	239	242	257	273	302	304
20°	232	237	251	253	270	286	316	319
42" Girder								
0°	261	267	283	286	304	323	357	360
10°	265	271	287	290	309	328	363	366
20°	278	284	301	304	324	344	380	384
48" Girder								
0°	211	216	253	256	280	397	437	441
10°	214	218	256	259	283	402	443	447
20°	221	253	275	278	396	419	462	466
60" Girder								
0°	216	220	258	260	284	401	441	444
10°	219	223	261	263	288	406	447	450
20°	226	257	280	282	400	423	465	469
72" Girder								
0°	222	227	264	266	290	406	445	449
10°	225	229	266	269	293	411	451	455
20°	232	263	285	288	429	428	470	474
84" Girder								
0°	230	233	270	273	296	412	451	455
10°	232	236	293	275	299	417	457	460
20°	239	270	291	294	411	433	475	479
96" Girder								
0°	237	241	278	280	303	418	457	461
10°	239	243	280	282	306	424	463	467
20°	246	277	299	301	417	440	481	485

Includes: Channel or Wideflange beam: Horizontal and Diagonal angles
(As required) Knee braces, all connection plates and bolts.

Note: Interpolate for skews not listed.

No Bearing Stiffeners of any kind included in the above table.

Add 13 lbs to the values from the table for the weight of flange connection angles when the angles are used.